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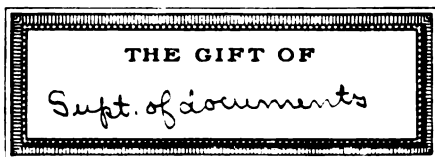
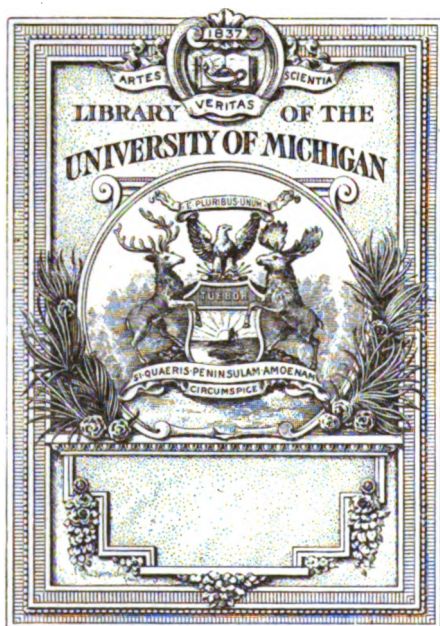
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Issued August 31, 1909.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS.

FIELD OPERATIONS OF THE BUREAU OF SOILS,
1907.

[NINTH REPORT.]

BY

MILTON WHITNEY, Chief.

WITH

ACCOMPANYING PAPERS BY ASSISTANTS IN CHARGE OF FIELD PARTIES.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1909.

[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the Congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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LETTER OF TRANSMITTAL

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., April 30, 1909.

SIR: I have the honor to transmit herewith the manuscript report, with accompanying illustrations and maps, of the field operations of the Bureau of Soils in 1907, the publication of which is authorized by public resolution No. 9 of the Fifty-eighth Congress, second session.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

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FIELD OPERATIONS OF THE BUREAU OF SOILS.

1907.

By MILTON WHITNEY, Chief.

GENERAL REVIEW OF THE WORK.

PROGRESS OF THE SURVEY.

At the close of the field season for the calendar year 1906 an area of 130,330 square miles, or 83,411,200 acres, had been covered by the soil surveys. The work accomplished during the calendar year of 1907 increased this amount to a total area of 149,801 square miles, or 95,872,640 acres, which had been covered by the soil surveys to December 31, 1907. The work for the calendar year 1907 thus covered 19,471 square miles, or 12,461,440 acres, a decrease of 772 square miles, or 494,080 acres, from the area mapped in 1906. During the calendar year 1907 from 12 to 18 field parties of 2 men each were maintained in the field work, and the rate of progress was considered satisfactory for the number of men and the amount of money employed in the work. During the year work which had already been begun was completed in 12 areas, and work was undertaken in 29 additional areas, of which 23 were completed before the end of the year, making in all 35 areas surveyed in 1907.

The average cost of the field work in 1907 was \$3.29 per square mile, an increase of 36 cents per square mile over the average for 1906.

The accompanying tables give in detail the location, extent, and cost of the soil-survey work carried on during the calendar year 1907, and also the total area covered in the different States and Territories of the United States.

Areas surveyed and mapped, and cost of field work, January 1 to December 31, 1907, inclusive.^a

State or Territory.	Area.	Area surveyed (square miles).	Cost per square mile.	Total cost.
Alabama.....	Butler County.....	b 485	\$2.35	\$1,137.77
	Henry County.....	150	5.95	c 892.87
	Lamar County.....	175	4.26	d 745.20
	Marion County.....	b 644	3.00	1,931.36
	Talladega County.....	b 705	2.37	1,669.88
Arkansas.....	Conway County.....	b 345	1.60	551.96
California.....	Colusa area.....	b 353	10.18	3,597.50
	Modesto area.....	450	6.41	2,883.77
	Redding area.....	200	7.08	1,416.84
Florida.....	Jefferson County.....	585	4.56	2,667.79
Idaho.....	Minidoka area.....	146	4.41	642.82
Indiana.....	Marion County.....	389	2.09	810.85
Louisiana.....	East and West Carroll parishes.....	220	2.68	590.24
	Winn Parish.....	b 703	3.49	2,453.75
Maryland.....	Easton area.....	966	1.78	1,721.33
Mississippi.....	Holmes County.....	366	1.42	520.85
	Jasper County.....	b 500	2.99	1,496.42
	Oktibbeha County.....	b 333	5.11	1,701.19
	Prentiss County.....	415	3.48	1,444.96
Nebraska.....	North Platte area.....	470	2.03	951.92
New York.....	Dutchess County.....	800	2.74	2,191.02
North Carolina.....	Edgecombe County.....	515	1.91	e 985.13
	Henderson County.....	366	2.77	f 1,014.60
	Robeson County.....	b 325	3.18	g 1,034.52
North Dakota.....	McKenzie area.....	348	4.45	h 1,550.14
	Morton area.....	544	3.13	i 1,701.07
Pennsylvania.....	Center County.....	317	5.39	1,710.11
	Johnstown area.....	714	2.30	1,646.00
South Carolina.....	Lee and Sumter counties.....	997	4.04	4,027.52
	Oconee County.....	652	2.77	1,804.25
South Dakota.....	Bellefourche area.....	190	6.83	1,295.04
Tennessee.....	Giles County.....	614	2.48	1,523.95
Texas.....	Bastrop County.....	839	2.78	2,331.25
	Brownsville area.....	189	6.96	1,316.62
	Cooper area.....	b 386	3.96	1,531.92
	Franklin County.....	294	2.08	610.39
	Robertson County.....	b 617	2.07	1,281.12
	Wilson County.....	b 456	2.18	995.51
Virginia.....	Montgomery County.....	393	3.77	1,483.92
Washington.....	Bellingham area.....	384	4.49	1,722.13
West Virginia.....	Middlebourne area.....	931	2.69	j 2,507.39
	Total.....	19,471	3.29	64,092.87

^a This includes the salaries of the men while in the area and their subsistence expenses, but not cost of transportation to and from the area.

^b These figures do not include sections of these areas surveyed in preceding years.

^c Of this amount \$378.57 was paid by the State of Alabama.

^d Of this amount \$407.28 was paid by the State of Alabama.

^e Of this amount \$365 was paid by the North Carolina department of agriculture.

^f Of this amount \$436.17 was paid by the North Carolina department of agriculture.

^g Of this amount \$240.28 was paid by the North Carolina department of agriculture.

^h Of this amount \$353.10 was paid by the North Dakota agricultural and economic geological survey.

ⁱ Of this amount \$376.69 was paid by the North Dakota agricultural and economic geological survey.

^j Of this amount \$999.62 was paid by the West Virginia geological survey.

Areas surveyed during the year ending December 31, 1907, and areas previously reported.

State or Territory.	Work during 1907.	Work previously reported.	Total.	
	Sq. miles.	Sq. miles.	Sq. miles.	Acres.
Alabama.....	2,189	7,912	10,071	6,445,440
Arizona.....		859	859	549,760
Arkansas.....	345	2,332	2,677	1,713,280
California.....	1,003	6,999	8,002	5,121,280
Colorado.....		2,428	2,428	1,553,920
Connecticut.....		505	505	323,200
Delaware.....		314	314	200,960
Florida.....	585	2,370	2,955	1,891,200
Georgia.....		2,425	2,425	1,552,000
Idaho.....	146	1,135	1,281	819,840
Illinois.....		5,921	5,921	3,789,440
Indiana.....	389	3,155	3,544	2,268,160
Iowa.....		2,303	2,303	1,473,920
Kansas.....		3,180	3,180	2,035,200
Kentucky.....		2,078	2,078	1,329,920
Louisiana.....	923	5,072	5,995	3,836,800
Maryland.....	966	2,610	3,576	2,288,640
Massachusetts.....		809	809	517,760
Michigan.....		3,788	3,788	2,424,320
Minnesota.....		2,197	2,197	1,406,080
Mississippi.....	1,614	4,091	5,705	3,651,200
Missouri.....		5,045	5,045	3,228,800
Montana.....		432	432	276,480
Nebraska.....	470	2,646	3,116	1,994,240
New Hampshire.....		923	923	590,720
New Jersey.....		1,303	1,303	833,920
New Mexico.....		129	129	82,560
New York.....	800	4,798	5,598	3,582,720
North Carolina.....	1,206	7,407	8,613	5,512,320
North Dakota.....	892	3,660	4,552	2,913,280
Ohio.....		4,143	4,143	2,651,520
Oklahoma.....		1,163	1,163	744,320
Oregon.....		442	442	282,880
Pennsylvania.....	1,031	3,006	4,037	2,583,680
Porto Rico.....		330	330	211,200
Rhode Island.....		1,085	1,085	694,400
South Carolina.....	1,649	4,897	6,346	4,061,440
South Dakota.....	190	484	674	431,360
Tennessee.....	614	4,137	4,751	3,040,640
Texas.....	2,781	9,940	12,721	8,141,440
Utah.....		1,501	1,501	960,640
Vermont.....		227	227	145,280
Virginia.....	393	5,590	5,983	3,829,120
Washington.....	384	1,268	1,652	1,057,280
West Virginia.....	931	645	1,576	1,008,640
Wisconsin.....		2,537	2,537	1,623,680
Wyoming.....		309	309	197,760
Total.....	19,471	130,330	149,801	95,872,640

COOPERATION WITH STATE ORGANIZATIONS.

In several instances the Bureau of Soils has entered into cooperative agreements with the State authorities of different States, in order to facilitate and expedite the making of soil surveys within those States.

The legislature of the State of Alabama during the calendar year 1907 enacted a law providing an appropriation for cooperation in making a soil survey of the entire State. The direction and expenditure of this fund was placed in the hands of the governor of the State and the commissioner of agriculture and industries. The Bureau of Soils furnishes expert field assistants, and the State of Alabama furnishes an equal number of State employees, from which the soil-survey parties working in the State are made up. The Bureau of Soils is charged with the inspection and correlation of the work in the different areas undertaken.

The parties thus organized carry on soil-survey work within the State during the entire year, and thus through this combination of the funds of the two organizations rapid progress is possible. It is hoped the soil survey of the entire State will be accomplished within a period of four to five years. The areas of which soil surveys are to be made during each year are selected through conference between the Federal and State authorities. They are distributed throughout the State in order to secure as rapidly as possible a full knowledge of the varied soil resources.

In North Carolina the North Carolina State department of agriculture has cooperated with the Bureau of Soils in making soil surveys for a number of years past, and this cooperation was continued in the conduct of the work during the calendar year 1907.

In 1907 a cooperative arrangement between the West Virginia geological survey and the Bureau of Soils was arranged for the prosecution of soil-survey work in West Virginia. The soil experts in charge of this work are furnished by the Bureau of Soils and the necessary field expenses of the party are paid from State funds.

REQUESTS FOR SOIL SURVEYS.

The number of requests for soil surveys on file at the Bureau of Soils has steadily increased since the inception of the work. There were on file on December 31, 1907, requests for the survey of more than 450 areas which had not yet been reached, covering in the aggregate nearly 500,000 square miles of territory, or an area about three and one-third times the total area surveyed from 1899 to 1907, inclusive.

These requests for soil surveys show great interest on the part of the agricultural public in work which is being done by the Bureau of

Soils, and it is noticeable that the most urgent requests for additional work come from regions where one or more soil surveys have already been made and where the usefulness of these surveys has thus been demonstrated.

IRRIGATION RECLAMATION PROJECTS.

In addition to the soil-survey work undertaken at the request of the farmers' associations, agricultural colleges, and experiment stations, and the general public, work has been undertaken in connection with Federal reclamation projects. Soil surveys were thus made of the Minidoka project in southern Idaho and of the Belle-fourche project in western South Dakota. The soil surveys of the different reclamation projects will be continued as funds are available for this class of work, in order that the new settlers who are taking up land under these Government irrigation projects may be fully informed in regard to the adaptations of the soils to different crops and the influence of the soil texture upon the irrigation of these crops, or of any possible accumulation of soluble salts within the soils.

NEED FOR EXTENSION OF THE SOIL SURVEY.

The extension of the soil surveys into new areas and new regions has greatly enlarged the general knowledge of our people in regard to the wonderful variety of the soil resources of the United States, and is yearly placing at their command more and more information as to crop adaptations and the opportunities for the extension of old and new industries.

The extension of soil surveys into the cut-over pine land sections of the Gulf States has shown that many of the soils occurring within this region are not only suited to the production of cotton, sugar cane, and other staple crops, but that certain soils possess a very high value for the production of vegetables and market garden and truck crops. Through the surveys in this region it will be possible to open for agricultural occupation several million acres of the longleaf pine land, upon which agriculture is now ready to make its beginning. Further study of the soils in this section will be necessary as the forests are removed.

It is desirable that soil surveys should be extended over the country lying west of the one hundredth meridian in order to determine the character of the soil and the crop adaptation of the soils of this part of the Great Plains region. It seems advisable to make a special study of the character and extent of soils suited for agriculture in the cut-over timber regions of the Great Lakes and to separate the agricultural soils from those suited only to forestry or other less intensive forms of occupation. It is highly important to continue the mapping of the arid lands which are being reclaimed, not only through the

operations of the United States Reclamation Service, but also of those brought under cultivation through the enterprise of private parties operating under the general provisions of the Carey Act. Another important problem is the determination of the special crop adaptations of considerable areas of dry-farmed land in the Interior Valley of California, which is now being subdivided into small tracts for the production of intensive crops under irrigation, as also the determination of the extent and distribution of the Houston soils in the Gulf States, which are especially adapted to the production of alfalfa and other forage crops. There is a call for further study of the grape and other fruit soils of the lower lake region in New York, Pennsylvania, and Ohio, and for the study of the soils particularly suited to the production of sugar beets in Michigan, Ohio, and Indiana. There are numerous other important soil investigations of the same class which could be enumerated, and which should be undertaken at as early a period as the funds and men can be provided for such work.

SOIL SURVEY OF DUTCHESS COUNTY, NEW YORK.

By CHARLES N. MOONEY and H. L. BELDEN.

DESCRIPTION OF THE AREA.

Dutchess County is situated in the southeastern part of the State of New York, between the Hudson River and the State of Connecticut and midway between New York City and Albany. The Hudson River forms the western boundary of the county, the distance being approximately 45 miles, while along the Connecticut State line the distance is somewhat less. On the south the county is bounded by

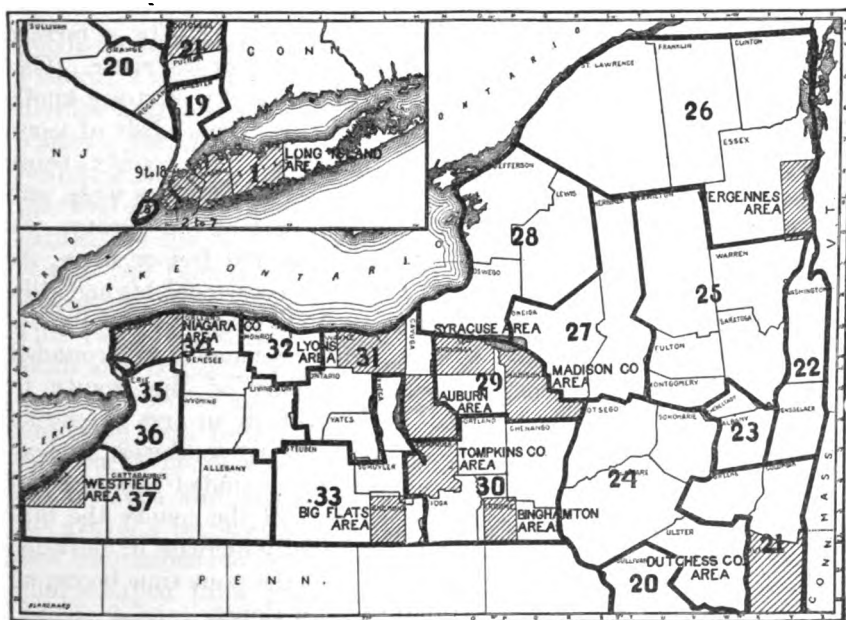


FIG. 1.—Sketch map showing location of the Dutchess County area, New York.

Putman County; on the east by Fairfield and Litchfield counties, Conn.; on the north by Columbia County, and for less than a mile in the extreme northeast by Berkshire County, Mass. It is included between the parallels of 42° 27' and 42° 5' north latitude, and meridian 74° west from Greenwich passes about a mile west of the most western point in the county.

The county comprises 511,872 acres or approximately 800 square miles. Politically it is divided into 20 towns (townships) with a total population of 81,670, as reported by the census of 1900.

Dutchess County possesses an uneven or diversified surface. It has no very extensive level or undulating areas, but hills and ridges of varying elevations are common, some of them over 1,000 feet in height, more or less rugged and mountainous, and cut by a number of troughlike valleys, the general relief being the work of preglacial erosion. The topography was modified to some extent during the Glacial epoch, as this section was glaciated, though feebly, and the result is shown in some parts of the county, where the surface is characteristically glacial, in that the hills, ridges, and even the mountains are more or less rounded or smooth in contour.

The elevations within the county range from sea level on the Hudson River, which here has a tidal flow, to a little over 2,300 feet on the highest mountain in the extreme northeast corner of the county.

From the Hudson River, which really occupies a gorge in the valley itself, the banks rise rather abruptly for the most part—in some places being sheer rocky precipices of 100 feet—to a terrace at its highest parts about 200 feet above the level of the river. This terrace is eroded to some extent and marked by rocky or stony knolls and ridges ranging from 25 to 300 feet high. It forms a belt of varying width along the whole extent of the river in the county, being broadest in the town of Red Hook, where it is 4 or 5 miles wide, and tapering to a point in the extreme southern part of the county. To the east of this terrace the hills or ridges rise 100 feet or more, increasing to a mean elevation of 500 feet, with occasional higher hills. From the towns of La Grange, Pleasant Valley, and Hyde Park a broad belt of rough, broken country, with occasional well-rounded hills, extends north through the central part of the county to the county line and beyond. East of this belt, in an area extending diagonally across the county from northeast to southwest, glaciation is marked, the hills being smoothed and rounded and often of drumlinoid shape. In the southeastern part of the county the hills rise about 300 feet above sea level, but gradually increase in elevation to 1,200 feet or more to the north and east, at the same time becoming broader and dome-shaped, with long, smooth slopes.

The mountainous part of the county lies along the southern and eastern boundaries. The Fishkill Mountains, which are a part of the Hudson Highlands, begin at the extreme southwest corner of the county. Breakneck Ridge rises abruptly at this point from the Hudson River as a bold promontory and extends south from the river to its highest point on South Beacon, 1,635 feet above the Hudson or sea level. The mountains on their southern sides break into precipitous cliffs or steep, rocky talus slopes, while the northern slopes are com-

paratively smooth, though steep. These mountains continue along the southern boundary of the county to the town of Pawling, but become less rugged and are continued or replaced to the northward by a high, broad ridge, known in part as Chestnut Ridge, the eastern side being steep and in places almost precipitous, forming the western wall or slope of the Pawling-Dover Valley. North of Tenmile River, in the town of Dover, the mountainous topography follows the eastern side of the Dover Valley, continuing along the Connecticut State line, with some interruptions, as rugged mountainous ridges, culminating in Brace or Monument Mountain, the highest point, at an elevation slightly over 2,300 feet, and on into the State of Massachusetts, where there are still higher points. South of Tenmile River and along the State line the topography consists of a high, broad, rolling, smoothed, glaciated ridge more than 1,000 feet in elevation, locally known as Quaker Hill.

There are three main interior valleys in the county, named from the streams which occupy them. The trend of these valleys is from the northeast to the southwest. These are the Wappinger Valley, which extends entirely through the county from Pine Plains in the northern boundary to New Hamburg on the Hudson; the valley of Fishkill Creek in the towns of Fishkill and East Fishkill, which divides near Hopewell Junction into two forks known as the Clove Valleys, the most extensive valley area in the county, the stream draining the central and southern parts of the county; and finally the well-defined valley extending the whole length of the county parallel to the eastern boundary and only a few miles distant, occupied by Tenmile River and its tributaries, Swamp River and Webatuck Creek, which join it from the south and north, respectively. This valley is really a continuation of the Croton Valley from the south and is locally known in the town of Pawling as Pawling Valley and in Dover as the Dover Valley. These valleys are pre-Glacial and have been formed by the relatively more rapid weathering of their rocky floors, which are composed largely of such soluble rocks as limestone and dolomite. All these valleys are characterized by flat gravelly terraces, contiguous to the stream courses, for the most part continuous but irregularly shaped and marked by smooth, drumlinoid-shaped hills, the work of glaciation, and by long, narrow ridges, feebly glaciated, with frequent outcropping ledges. The pre-Glacial valleys have been partially filled and the drainage channels obstructed by depositions of glacial débris, whereby ponds and small lakes or swampy and meadow areas have been formed. Some sections, however, hardly show glaciation at all, the ice having scoured off the surface and left little or no glacial débris. Since that time these localities have been subjected to the agencies of weathering and erosion. These areas are in contrast with those

smoothed by the ice and covered by a mantle of glacial till, being marked by a rough topography and frequent irregular rock outcrop.

Poughkeepsie, the county seat, on the Hudson, midway between the northern and southern boundaries, is the largest city, having a population of about 25,000 at the last census. It has important manufactures and is a railroad center and shipping point for the river traffic. It is also the site of Vassar College. Fifteen miles south of Poughkeepsie, on the Hudson River, are Fishkill-on-the-Hudson and Matteawan, practically a single place, with a combined population of over 10,000 and second in importance both in population and in manufacturing. The power for all factories is obtained from Fishkill Creek. Wappingers Falls is another important manufacturing town. It has an important water power in Wappinger Creek. There are numerous other villages scattered over this county, some of them noted chiefly for their summer residences of wealthy city people. The towns of over 1,000 population are Rhinebeck, Millbrook, and Tivoli. The most important towns of less than 1,000 population are Fishkill village, Hyde Park, Staatsburg, Rhinecliff, Red Hook, Pine Plains, Pawling, Dover Plains, Amenia, and Millerton, the last being a railroad center in the northeastern part of the county.

The drainage of the county is mostly effected by a number of important creeks with numerous tributaries, the general direction of flow of the main streams being to the southwest into the Hudson River. The larger creeks are Fishkill, Wappinger, Fallkill, Crum Elbow, Landsman Kill, and Stony. Roaloff Jensen's Kill drains a part of the towns of Milan and Pine Plains, barely entering the county itself and flowing northwesterly through Columbia County to the Hudson. On the east the drainage is into Tenmile River, and then into the Housatonic River in Connecticut. On the south the main tributary is Swamp River, on the north Webatuck Creek. All these streams are swift, flowing over rocky floors, with numerous rapids and occasional falls.

There are numbers of ponds and lakes in the county which are the sources of the larger streams. They are without exception due to obstruction of drainage by glacial action or by artificial damming. The principal ones are Whaley and Stissing ponds and Sylvan Lake.

The county has exceptionally good transportation facilities both by rail and by water. Railroads touch nearly all points in the county or at convenient points in adjoining counties, so that no section is far distant from a railroad station. Two divisions of the New York Central Railroad traverse the county from north to south; the Hudson River Division in the western part follows the bank of the Hudson River and the Harlem Division passes through the valley in the eastern part of the county. On the opposite bank of the

Hudson River the West Shore Railroad, to which connections are had by ferry from Fishkill, Poughkeepsie, and other points, also affords some service to the county.

From east to west the Central New England Railway and the Hopewell branch of the New York, New Haven and Hartford afford connections from interior points with the main lines of the New York Central Railroad, particularly at Brewster and Millerton. Electric lines connect Poughkeepsie, Wappingers Falls, and Fishkill Landing with Fishkill village.

The bulk of the freight, both through and local, is carried by water by the numerous steamboat lines on the Hudson River, at rates cheaper than those of the railroads, and the service is very satisfactory. Numerous highways reach the various shipping points and are kept in excellent condition.

Farm products meet with ready sale in the manufacturing and residential towns of this and neighboring counties, but New York City is the principal market. Dairy products, particularly milk, are shipped to New York City or its vicinity. Fruits are also sent to these markets, but fancy apples bring better prices abroad, particularly in England, and large quantities are exported. Violets, the growing of which is a specialty in a certain part of the county, find a market in New York City and other cities in the State, in New England, and even as far west as Chicago, the latter city being considered an especially good market.

The settlement of Dutchess County began about two and a quarter centuries ago, at about the same time as, or a little later than, the neighboring counties as at present organized. The settlement of Dutchess County was begun and developed in two separate sections by people of different nationalities. The earliest settlement was made by the Dutch from New York and Albany in the section along the Hudson River, while the valley in the eastern part of the county contiguous to Connecticut was settled by pioneers of English descent from New England. The first authentic settlement in the county was at what is now Fishkill village, in 1682, and was followed a few years later by settlement at Poughkeepsie and Rhinebeck.

The eastern part of the county was not settled to any extent until fully a half century later than the section along the Hudson, although there had been an occasional settler early in the century. About 1741 a number of English Quakers from Rhode Island and Long Island settled in the eastern part of the county and it is said they became quite numerous by 1755. Their descendants now form a considerable part of the population of that section. Pioneers from Connecticut and other New England colonies also became settlers in this county.

The development of the county was slow, the chief difficulty being the manner in which land was held, which was upon leaseholds. In 1683 the county had been organized, but for administrative purposes was provisionally attached to Ulster County until 1713. By 1714 the county population amounted only to 445, of whom 29 were negro slaves. The second half-century after settlement marked great increase in population, for by the time of the Revolution it had reached about one-fourth of what it is now and was extending to all parts.

The whole county is now settled, though in the rougher parts rather sparsely. According to the last census (1900) Dutchess County has a population of 81,670. Nearly one-third of this is in Poughkeepsie, while of the remainder, something over one-half is in the towns, so that the urban population exceeds the rural.

The present population is not only composed of descendants of the early settlers, who represent a large proportion of the population, but in addition there are, aside from laborers in manufacturing industries, many new residents, among them, of course, farmers and farm laborers. City business people are also buying farms and estates and living upon them the whole or part of each year. Foreigners are also represented, but many of these are transient. They are principally Italians, who labor on the public works as well as on farms and estates. Some Poles, Swedes, and Norwegians are found, and other nationalities to a less extent.

During the last few years, owing to the scarcity of labor, negroes have come from the South, particularly from Virginia, and a considerable number are at present employed as farm hands. but many of them return to the South for the winter months.

AGRICULTURE.

In 1683 Dutchess County was organized by the English. It then included the present county of Putnam and two towns of Columbia County. Following the act of organization the Provincial Government gave grants of land to individuals and organizations on the conditions that the claims of the Indians should be satisfied and the lands settled. The fact that the land was not disposed of to settlers in fee, but merely leased, delayed settlement for the first half century.

The original forest growth was deciduous, but there were some evergreens; hemlock was found in the ravines, ground hemlock on the higher ridges, black pine on the mountains, and tamarack in the swamps. Poplar and wild cherry were abundant. Oaks sprang up as a second growth in areas which had been swept by forest fires. Chestnut also formed a considerable part of the original forest.

The early settlers were vigorous and industrious. They cleared sufficient land to cultivate, and after clearing removed the larger

stones from the fields, so that cultivation would be less difficult. Maize and wheat were the first cultivated crops.

The population after the first half century steadily increased, and in 1756 Dutchess County had the second largest county population in the Province, and was the richest agriculturally. In 1800 the population had reached 50,000. Manufacturing was coming into importance by this time; hats were being made, and carding and fulling mills operated a number of looms. In 1813 Spofford said the county was "unequaled in the State for farm improvements and practical farming."

Wheat became the principal cultivated crop in the western part of the county within reach of the Hudson, and much of it was sent down the river to the cities for export. Oats, flax, and other crops were produced, and sheep and cattle were kept on every farm. Fallowing was practiced at this time, a field being left idle for a year or two and then again cultivated. The practice was employed rather because land was plentiful than for any other reason. Wheat yielded 20 to 25 bushels for one of seed to the acre, and wheat production increased during the first half of the nineteenth century. In 1835 over one-third of the grain shipped from the State came from Dutchess County.

The opening of the Erie Canal in 1825 brought western wheat into competition with the local product, and as the yields were becoming less because of continuous cropping the production of this staple gradually declined. The eastern part of the county meanwhile had developed along other agricultural lines. Its lack of river transportation and remoteness made the marketing of wheat expensive and tedious. The grasses, however, were nutritious and abundant and the farmers therefore raised live stock, which could be marketed much better than the grasses, although the stock had to be driven down the Harlem Valley 70 miles to New York. This system of farming produced sufficient manure to maintain and increase the productiveness of the soil.

The roads built in the latter part of the eighteenth century were an additional convenience from a transportation standpoint. The old "Post road" passed through the towns along the Hudson to New York City. Later a road was laid out through the Harlem Valley from New York to Bennington and soon a network of roads crossed the county in all directions.

According to the census of 1840 the staple crops of the county were hay, oats, corn, rye, wheat, buckwheat, barley, and potatoes, the cereals ranking in the order named according to the number of bushels produced. The figures of that date show a maximum production as compared with later reports, although it is very probable that the returns were larger prior to 1840, as a decline in the production of

cereals had been taking place. Hay outranked all the crops and has remained in the same position. The production of oats in 1840 was 1,360,000 bushels, and a steady decrease has taken place from decade to decade.

A decided decrease in wheat production, amounting to 100,000 bushels, occurred in the decade between 1840 and 1850. At the former date the production was 170,000 bushels. From 1850 the production of wheat has steadily decreased, but in the decades of 1870 and 1880 there was an increase, due, perhaps, to unusually favorable seasons for the years reported. There were 87,000 bushels of buckwheat reported in 1840, but the quantity produced has gradually decreased to about one-half the former production. The yields of barley varied throughout this time, being lowest during the last two decades. Potatoes were an important crop in 1840, the census figures showing a production of 590,000 bushels. This crop has gradually fallen off to about one-half that of 1840. The corn crop has fluctuated very little since 1840, being apparently a standard staple, although in 1870 and 1890 a decrease in yields was reported. The general average production for the seven decades has been 700,000 bushels.

The building of railroads in the forties allowed quicker transportation of western wheat and beef, and coincident with the opening of these roads came a further diminution in the production of wheat and beef cattle in this county. In other ways the railroads were beneficial. In 1849 the Hudson River Railroad, now the New York Central, was built as far north as Poughkeepsie, and in 1851 was extended to Albany. At this time the Harlem Division of the New York Central Railroad was completed through the eastern part of the county, and the value of town property along this line was doubled. As a result of western competition in beef cattle, the farmers of Dutchess County in the eastern and later in the western part turned their attention to dairying. There was an additional reason for this. The railroads offered facilities for the quick shipment of more or less perishable dairy products to the cities, New York in particular, where the increasing population created an active and steady demand for these commodities. Dutchess County was exceptionally situated to provide these markets, being only a few hours distant by rail. In the eastern part of the county sheep raising was also taken up. In 1840 the census returns gave 216,000 as the number of sheep in the county, but in the next decade the number had decreased one-half, and to-day, on account of gradual decline, the industry is of minor importance.

The interior of the county was opened up by the building of the Newburg, Dutchess and Connecticut Railroad in 1869, which made possible the shipment of milk to the New York market from this section. The Poughkeepsie and Eastern Railroad was built in 1870-1872, the Rhinebeck and Connecticut in 1874, and the branch road

from Hopewell to Brewster in 1881. These roads furnished adequate shipping facilities for the remainder of the county previously untouched by railroad lines.

Dairying is now the most important industry in the county. Its development since 1850 has been steady, 18,000 milk cows being reported by the census of that year. The number has now doubled. There has been no appreciable increase in the number of cattle other than milk cows.

The milk at first was made into butter and cheese. Cheese making did not prove profitable, however, and is not now important. After 1860 butter making became less general and milk shipments increased. Butter making is still of some importance as an industry, however, the census showing the number of pounds made in 1899 as 690,000 and the milk sold as 13,000,000 gallons; an increase in the latter of 5,000,000 gallons since 1870, and a decrease in the former of 2,000,000 pounds since 1850.

The farming is more specialized at present in this county than at any time in its history. Dairying being the principal industry, crops are grown with reference to supplying the demand of the dairy. Milk is sold from nearly every farm, and milk stations are established at many points on all the railroads. In the vicinity of a milk depot the farmers bring in the milk by wagon, but from territory more distant from a depot it is carried to the nearest railroad station, where arrangements for keeping it are made, from which point it is sent to the central depot. At the depot the milk is separated and brought to a certain standard, cooled, bottled, and sent to market. The railroads run special trains with refrigerator cars suitable for carrying milk. As a general rule the farmer sells his milk to the various milk companies, rarely shipping it to market himself, except when producing certified milk. Certified milk brings about 3 cents more per quart than the uncertified. There are a number of dairies scattered over the county producing certified milk, but there is a tendency to abandon its production on account of the very strict supervision exercised. On the whole the sanitary condition of the dairies is being improved. The price at which ordinary milk is bought is fixed by the milk distributing companies, and is not entirely satisfactory, being only one-half the market selling price, and varying with the seasons. It is claimed that the distributor makes a greater profit than the producer. This condition could probably be remedied by united effort on the part of the dairymen; for although the quantity of milk marketed or sold by each is small it would be possible by combination to obtain better prices than from the companies. The quality of milk is probably much better under the present arrangement than it would be if each individual sent his supply to market

independently. Some of the milk is condensed, and there is a large milk-condensing establishment at Wassaic.

The dairy cows are almost entirely grades; those of Jersey and Holstein blood are preferred and are most common.

In order to furnish feed for the dairy cattle, a large part of every farm must necessarily be in grass for hay and pasture. Of the average-size farm four-fifths of the improved land is in grass and something over one-half is in more or less permanent pasture. The average farm cuts 30 acres of hay, averaging slightly over 1 ton to the acre, although some fields which have been cut for hay for a long time do not yield more than one-fourth ton per acre. With better treatment and application of fertilizers, 2 tons or more can be obtained.

Timothy and redtop and some clover are the principal hay grasses. Oats is also largely cured for hay or used as a green soiling crop, comparatively little being thrashed. Corn is next to hay in importance, its acreage being about one-fourth that of hay. Corn is largely made up into ensilage, most of the varieties grown being suitable for that purpose. Silos are very common throughout the county, and the use of corn for ensilage is the most economical and profitable method of feeding. Some of the milk companies object to the use of ensilage, especially when the milk is to be condensed, alleging that it has a peculiar effect on the condensed product.

Wheat is grown, but not universally. Buckwheat is sown on most farms, especially on the slaty land, where it succeeds fairly well, and is no doubt one of the best crops on that type of soil. The average yield per acre of buckwheat in 1899 was about 15 bushels, of wheat and of rye 14 bushels, of oats 23 bushels, and of corn 29 bushels. Potatoes are grown universally, but in small patches, barely enough being produced for home consumption. On the gravelly and sandy valley soils and river terraces some fields were seen where this crop was being grown for market. The average acre yield is low, being but 80 bushels, according to the last census.

Orcharding, particularly of apples, supplements dairying. There are a number of large orchards, but most of them are small. The soils and climate are suited to the growing of apples, and labor, which at other times is scarce, can be obtained during the picking season from the cities, as at this time better wages are paid than usual. Peaches, plums, cherries, and some other fruits are also produced to a limited extent. The value of orchard products in 1899 was reported as \$377,427. These figures represent a substantial progress, as in 1850 the value of orchard products was \$15,886; in 1860, \$92,189; and in 1870, \$173,148.

The Baldwin apple is the favorite, but the King, Rhode Island Greening, Pippin, and a number of other varieties are grown. Some

of the best fruit finds its way into the export trade, particularly to England. Newtown Pippins are all sent to the cities, and the red varieties of apples are now in demand for the export trade.

Indications point to a greater fruit production in the county. Some years ago the growing of grapes on the slopes of the Fishkill Mountains and along the Hudson was quite an important industry, but this has been almost wholly abandoned. In the eastern valley, near the town of Dover, some tobacco, both wrapper and binder, was formerly produced. This industry was started in the fifties on a commercial scale, reached its height in 1880 with 280 acres with a yield of 400,000 pounds, and since that time has gradually fallen off and is still declining. The average yield is about 1,500 pounds per acre. The lower lying gravelly phases of the upland soils (Gloucester loam and Gloucester stony loam) and the gravelly soil (Merrimac gravelly loam) of the valley are the soils on which tobacco is planted.

Violets are an important special crop, particularly in the vicinity of Rhinebeck, and their superiority has made this section widely known throughout the country. There are over 100 commercial growers near this town, and a few are located in Red Hook, to the north, and in towns to the east. The soil in that section has proven well adapted to their production. Although the growers claim that the climate is important, it is probable that the soil is the determining factor. The soil used for the most part is the Dutchess stony loam, although some other soils are also used in different localities. New soil is selected each year and the practice is not to use it again, although it is probable that it could be used after an interval of rest.

Much of the merchantable timber has been removed, but considerable cordwood is cut. Quite a large area is still forested, the growth being chiefly oak and chestnut. Locust and cedar grow abundantly around the fields, and if these were more extensively grown for fence posts they would undoubtedly bring good returns. All the soils support a grass sod, but the limestone soils are prized particularly as grass land, for hay and pasture, and for general farming. The soil from the dolomites is not quite so strong, but has a comparatively high value. The limestone soils will also grow the heaviest corn crops. All the upland soils are good grass soils, but the Gloucester loam and the Dutchess silt loam are the heaviest, strongest, and least stony of these. The Hudson clay loam is also a strong grass soil, and in Columbia County, to the north, is used for grapes. All of the upland soils where drainage is good and the location favorable are good types for fruit. Apples on the Dutchess silt loam, however, though of excellent flavor and keeping quality, do not, as a general rule, color so deeply and so uniformly as on the slaty lands and the Dutchess stony loam. This latter soil is particularly important in fruit production in the town of Red Hook. Climate in this region seems

to be the controlling factor, as farther inland the fruit does not do so well, even on the same soils. The gravelly loam of the stream valleys and the gravelly and sandy soils of the terraces mature early varieties well, and the fruit has a good color and fine flavor.

The gravelly loam in the valleys is a fairly good corn soil, especially where not too leachy. The lighter soils do well in potatoes, tomatoes, and garden crops. The Hudson fine sandy loam is well adapted to small fruits and trucking, but very little truck is produced.

Crop rotation is practiced to some extent, but no system is followed closely. The rotation includes corn one year, oats or rye one or two years, then grass for hay two or three seasons, followed by a year or two of pasturing. The soil is fairly well prepared for seeding and receives good cultivation even under present labor conditions. Farm machinery is used where the soil is not too slaty and stony, and generous quantities of fertilizers are applied. The manure on the dairy farms is applied to the fields, but more care could be taken to prevent waste. Instead of leaving it in the barnyard it would be better to apply it to the meadows in the winter as made, so that it could be utilized to the best advantage. Corn land is always manured heavily. Some lime has been burned in the county and applied to the land, but the practice is not common. It has always proved beneficial and should be used more generally. Orchard trees are grown in grass sod and the grass cut and left for mulch, or, more generally, sheep and hogs are turned in. Many orchardists would prefer to cultivate the orchards, but do not do so, as labor is scarce. Spraying is practiced by only a few growers, although the cankerworm in some places has done much injury.

The demand for labor is active, especially on the dairy farms. In recent years foreigners have been used for this work, principally Italians, with a few Danes and Poles. Some colored labor is now coming in from the South, especially from Virginia. The wage paid them is about \$20 a month and board.

Ninety-one per cent of the land in Dutchess County is in farms, 75 per cent being improved. Since 1890 the percentage of improved land has fallen, as 87 per cent at that time was improved. This condition may be due to labor conditions, some of the land formerly cultivated being allowed to revert to forest. The average size of farms is 132 acres, a slight increase in the last thirty years. Much of the land is included in large estates containing several thousand acres. The tendency, especially along the Hudson River, is to make these estates larger. About 67 per cent of the farms are operated by the owners. Renting is practiced both on a share and on a cash basis. There are a number of estates managed by a farm manager or superintendent.

The value of the land according to the last census is, on the average, \$44 an acre. This shows a decided decline, as in 1880 the average value was \$73 an acre. The average value per acre when applied

to farming lands is too high, as the average is greatly increased by the high price of land near the Hudson in the large estates. Farm values vary greatly, the rougher and more stony lands commanding comparatively low prices, not more than a few dollars an acre, and the better class of lands bringing very high prices, depending, of course, on nearness to railroads and general desirableness. It is almost impossible to state definite acreage values for the land in this county, on account of the many factors which influence values.

The farms have an appearance of thrift and prosperity; the houses are commodious, well painted, and in good repair; the outbuildings and barns for dairy stock are large and well kept, and the fields are fenced with stone walls. The taking of summer boarders is universal, and adds considerably to the farm income. There are also several summer hotels in the county, which offer opportunities for disposing of farm products near at hand. The country roads are good, and many of the homes have telephones, and the rural free delivery of mail is general.

At the present time the greater number of the farmers have to purchase grain, as not enough is produced on the farms to feed the stock, and this outlay cuts down the net returns. A leguminous crop would help to eliminate this expenditure, and should form a part in the crop rotation on every farm. Clover has succeeded in the county, and though difficulty is experienced in getting it to grow the failure may probably be attributed to poor seed. The effort should be made to obtain good seed, as the crop is nutritious and suited to the needs of dairying. Soy beans, no doubt, would succeed and, like clover, would be a good soiling crop and improve the land. Alfalfa would doubtless succeed on the limestone soils, as it has done well on similar soils in other parts of the State. The land should not be left in grass sod for so long a period as in the present crop rotation.

The sandy and gravelly types should be devoted to truck crops and small fruits, and the areas too rough and stony to cultivate with fair profit should be allowed to return to forest and a good system of forestry followed.

SOILS.

A comparatively large number of soils were recognized and mapped in Dutchess County. In addition to areas of Rock outcrop, Rough stony land, Meadow, and Madeland—self-explanatory terms used in soil classification to denote a condition rather than a difference in soil texture—seventeen types of soil were mapped. These soils may be separated into two general groups with relation to position and origin—those in the uplands closely associated with the various underlying rock formations partly of residual and partly of glacial origin; and those in the interior stream valleys and along the

Hudson River, made up of water-transported materials or sediments. The upland soils may be again separated with reference to the kind of rock from which derived or with which each is associated, and the sedimentary soils may be separated not only upon differences in the kind of sediments transported and deposited, but also as to the place, manner, and time of deposition. These divisions, it may be said, correspond to the soil series in soil classification, each series representing a group of soils of like derivation and mode of formation, each type unit being a separation based upon textural and structural differences or upon some other important factor, such as the kind and quantity of stone in the soil.

Thus the upland group of soils associated with the underlying rock formations was found to embrace eight soil types, representing three soil series, and the sedimentary group ten soil types, representing four soil series.

All the soil material has been more or less affected by glaciation, being either derived in part from glacial till as originally deposited or as more or less modified by other agencies since deposition. Glaciation, however, on the whole, was rather feeble; in some parts the ice sheet must have merely scoured off the shallow soil mantle and broken the underlying rock ledges. In such places the resulting soil is mainly residual, although in places influenced by glacial material. In other places some of the rocks were ground to powder or were merely rounded off and the material left in place, or again, it may have been transported possibly some distance and deposited to a considerable depth, leaving the surface smooth and rounded. The direction of the glacier being along the longer axis of the rock beds, there was very little intermingling of material from the different rock formations; hence the soil material formed by the breaking down of the underlying rock predominates and determines the nature and character of the soil. Some of the material may have been transported, but if so it has been carried along the same rock formation and has therefore the same derivation. Thus, because of the close relation between the soils and the rocks, it is necessary to have a knowledge of the underlying formations to understand the resulting soils.

The rocks are of the older formations in the geological scale, ranging from pre-Cambrian to Silurian, and varying from igneous, metamorphic, crystalline rocks to sedimentary rocks, the latter consisting of shales, slates, grits, limestones, and dolomites, with variations and blendings in all the forms.

The oldest formation occupies the southern and eastern parts of the county, making up the Fishkill Mountains, a part of the Hudson Highlands, and the mountainous ridges along the Dover-Pawling Valley and the Connecticut State line. It consists of granite flanked

on the sides by a thin-banded micaceous gneiss, the whole formation being known as the Fordham gneiss. Its topography is mountainous. Glaciation evidently took place, although it was not very severe, but there occur on the surface large and often huge boulders that are more or less rounded. Because of their number and the outcrops of rock on the surface, as well as the general rough topography, the greater part of this formation has been mapped either as Rough stony land or Rock outcrop. Less stony areas occur, however, and these have given rise to the Gloucester stony loam, a soil type also extensively developed and distributed over New England. In the southeastern corner of the county, forming the ridge known as Quaker Hill, is the Hudson schist, a metamorphic rock of Silurian age. It is a mica schist from which is derived the mica found so abundantly in the soil mass, but the rock varies slightly, blending on the one hand into micaceous thin-banded gneiss and on the other into the less micaceous slate of the Hudson slate group. The Hudson schist is a comparatively soft rock which was easily ground up by the ice, and as a result a considerable depth of soil material was left and the surface smoothed. A comparatively small quantity of stone is found in the soil. This formation gives rise to the type of soil called the Gloucester loam, a type not previously encountered, and to small areas of Rough stony land.

Forming the floor of the eastern valley, the Pawling-Dover-Amenia Valley, is another rock formation known as Stockbridge dolomite of Cambro-Silurian age, consisting of distinctly bedded and generally coarsely crystalline limestone and dolomite, in some places highly metamorphosed, forming a dolomitic marble. Aside from the agricultural value of the soil, the marble has a high commercial value. The Stockbridge dolomite is separated from the gneiss formation by a bed of quartzite, which has no influence on the soils, as it is included with the Rough stony land of the gneiss. On the east side of the valley it grades into the Hudson schist. This rock decomposes and disintegrates easily, and the soil formed is of a fine, silty, sandy texture and fairly productive. The extent of this type is not large, the continuity of the areas being broken by overwash of glacial gravel. The soil is doubtless largely residual, although modified to some extent by glacial material. The resulting soil has been called the Dover fine sandy loam.

To the west of all these formations and underlying the greater part of the county is what is known geologically as the Hudson River group or series of rocks, of sedimentary origin and of Silurian age. This group consists of a series of slates, shales, grits, limestones, and siliceous and calcareous breccias and conglomerates. These have been modified or metamorphosed to some extent in places by the intrusion of plutonic rocks and have been broken up and

tilted at various angles to the surface, as well as bent, wrinkled, and contorted in almost every conceivable manner, and elevated into hills and ridges. They are stratified and the different beds alternate a great number of times without any regular sequence. Within the group there are varying combinations in the different beds which grade into one another, as, for example, shales and slates which range from argillaceous to gritty or sandy, and grits, from shaly or slaty to massive or thickly bedded. Some beds are highly calcareous, while others are not. The slates and shales are generally dark brown, blue, or black, and the grits are gray, greenish, and bluish gray. Near the Hudson the rocks are mostly grits and give rise to the Dutchess stony loam. To the eastward the slates predominate. East of Wappinger Creek the formation is claimed to be more or less metamorphosed, developing talcose and chloritic slates in places, and even hydromica slates approaching schist. The less severely glaciated part gives rise to the Dutchess slate loam, a soil containing large and varying quantities of slate fragments and larger stones and slabs. These two soils seem to be largely residual, and only here and there contain any considerable quantity of glacial till. To ice action possibly, as well as to postglacial weathering and erosion, may be due the breaking down of the rocks in place. Through the central part of the county glaciation was more severe, and smooth glaciated hills are scattered here and there through the rougher parts. In these places is found a greater depth of soil material—a heterogeneous mass of fine earth, gravel, and stones—which indicates that the mass is largely glacial and probably transported, although derived from rocks similar to those of the underlying beds. The depth of material ranges from a few inches to an unknown number of feet. The effect on the topography has been to smooth the surface, and some glacial forms, such as drumlin-shaped hills, occur. The soil mass is compact, making the soil more retentive of moisture and apparently heavier than the more stony soils. The soil has intermingled with it, however, varying quantities of stone and gravel, and on the surface some boulders as well. It is affected to some extent, especially where shallow, by the underlying rocks, which vary slightly, and the soil is sometimes more silty and again more sandy than is usual. As a whole, the soil is a granular, friable, light silt or silty loam. It has been classed as a silt loam under the name Dutchess silt loam.

Limestone areas occur in most of the valleys and give rise to a heavier soil than that formed by the dolomites in the eastern part of the county, the type developed being a light silt loam. The soil mass is largely made up of residual material, but has been affected to some extent by glacial drift. The topography is ridgy and rather rough, with numerous outcropping ledges of limestone. The soil

has been called the Dover loam and is a comparatively strong, productive, and desirable soil.

All of the foregoing soils may be classed as glacio-residual, formed by the intermingling of transported glacial drift and material derived from the breaking down of the underlying rocks. The overlying soils derived from the igneous and metamorphic rocks are included in the Gloucester series, those from limestones and dolomites in the Dover series, and those occurring in the Hudson River group in the Dutchess series. The last two named series are new in the soil classification, but the first mentioned occurs generally throughout New England.

The sedimentary group of soils consists of three classes, separated on a basis of manner of formation and place of deposition—that is, modified or reworked glacial drift, glacial lake, and alluvial. All of these are, in fact, reworked glacial material transported and deposited under different conditions. The first two classes were formed at the close of the Glacial epoch, but the alluvium is of recent origin. The modified drift soils occur in the interior valleys as gravelly overwash plains and gravelly dumps. At the close of the Glacial epoch, when the ice was melting and receding, the glacial streams from the ice front carried large quantities of glacial débris, consisting of gravel and fine earth, which was reworked and deposited in layers or strata by the water in the stream valleys. As evidenced by the coarseness of the material this deposition was probably made in swift running water. Three types of soil were recognized, a gravelly loam, a gravelly sandy loam, and a loam, which have been given the series name of Merrimac. The glacial lake or lacustrine soils represent sediments deposited in a glacial lake. At the close of the Glacial epoch, when the ice was all melted in the Hudson Valley, except in the Hudson gorge now occupied by the river, the river was obstructed or dammed at the Highlands and a lake was formed along the river, named by geologists Lake Albany. The water carried for the most part sediments which were slowly deposited, forming the great and valuable deposits of clay now used for brickmaking along the river. Over a great part of it, however, sandy deposits were made, forming the sandy types of soil, which must have been deposited in shallow and moving waters. Four types of soil have resulted, varying in texture from a silty clay loam to a medium sandy loam. These have been included in a new series called the Hudson series.

The alluvial soils are the recently formed flood plains deposits along the stream courses and are not extensive, as the streams are still cutting their channels rather than forming flood plains. Two types of soil were found, a fine sandy loam, occurring with or in some places being the wash from the soils derived from the metamor-

phic crystalline rocks in the eastern part of the county. This soil has been correlated with the Podunk soils occurring along the Connecticut and Merrimac rivers in New England. The other type is a variable soil classed as a silt loam, called the Huntington silt loam, occurring along streams throughout most of the county.

The different soil types, together with areas of Rock outcrop, Rough stony land, and Meadow, are shown by colors on the accompanying map, and Madeland by symbol.

The name and actual and relative extent of each soil are given in the following table:

Areas of different soils.

Soil.	Acres.	Percent.	Soil.	Acres.	Percent.
Dutchess silt loam	117,184	22.9	Dover fine sandy loam	8,512	1.7
Dutchess slate loam	94,144	18.4	Gloucester stony loam	8,256	1.6
Rough stony land	77,440	15.1	Hudson fine sandy loam	6,400	1.2
Dutchess stony loam	51,776	10.1	Hudson loam	3,904	.8
Merrimac gravelly loam	41,216	8.1	Rock outcrop	3,328	.6
Dover loam	28,800	5.6	Hudson sandy loam	1,856	.4
Meadow	24,192	4.8	Merrimac loam	1,600	.3
Huntington silt loam	11,200	2.2	Rhinebeck loam	1,088	.2
Gloucester loam	10,752	2.1	Madeland	448	.1
Hudson clay loam	9,984	1.9	Podunk fine sandy loam	192	.....
Merrimac gravelly sandy loam	9,600	1.9	Total	511,872	.....

DUTCHESS SILT LOAM.

The Dutchess silt loam is the most widely distributed soil type found in Dutchess County. It has been formed from a shallow mantle of glacial till spread over a variety of rocks, each of which to some extent has influenced the soil formation, causing here and there slight textural differences, as well as some differences in color and in the kind of rock fragments left in the soil mass or strewn upon the surface. Upon the whole, however, it is a fairly uniform type and one readily recognized. A profile section of the Dutchess silt loam would show a surface soil 8 or 10 inches deep consisting of a friable silt loam or silty loam of light or yellowish-brown color, underlain by similar material of a lighter or yellowish color and somewhat more compact. The demarcation between the soil and subsoil is fairly distinct, the first few inches of the subsoil being lighter in color than the soil and changing to a brighter yellow.

The mechanical analyses of typical samples of this type show that one-half or more of the fine earthy material is silt, about 10 per cent is clay, and about one-third is made up of the coarser grades, which are about equally divided between the very fine, fine, medium, and coarse sands, and fine gravels, the coarser particles being sufficient in quantity to give the soil a granular character.

It is possible that to some extent the friableness of the soil may be due to humus matter and the result of cultivation. The subsoil because of its compactness seems apparently heavier, but the analyses show little difference in texture. In places, however, the subsoil seems more sandy than the soil, which is probably attributable to the lack of organic matter, although where closely associated with the more gritty rocks it is actually more sandy.

The variations in the texture, however, are slight and are not sufficient to make separation possible. These variations are due to the character of the rocks from which the soil is derived, although the soil mass may not be derived directly from the immediate underlying rock. Where more closely associated with the gritty rocks, the soil is decidedly more gritty or sandy and in some locations might better be described as a gritty or sandy silty loam or light loam. Where it is associated with the argillaceous slates the material is possibly more silty, and where the rocks are more calcareous the material is heavier and has a slightly reddish cast. In the valley areas occurring in the vicinity of Millerton, where the metamorphosed slates carry more carbonaceous beds, the soil is also pronouncedly silty, of a darker color, and somewhat micaceous, approaching the character of the Gloucester loam overlying the Hudson schist. In this valley it is also associated with limestone and dolomite beds, and though influenced slightly by them is often regarded by the farmers as limestone land and highly desirable because of the generally small stone content. A still further variation is that found on the "wet slopes," as they are called, of the hills. These slopes represent a condition of comparatively poor drainage induced by the imperviousness of the compact soil material. The soil is somewhat more silty here and is drab colored, while the subsoil is possibly a little heavier, somewhat plastic, and mottled drab and yellow or sometimes simply light drab in color.

The soil is spoken of commonly by the farmers as cold, wet clay. In fact, as a whole, it is regarded by them as rather heavy and clayey. The depth of the soil mass is variable, usually stones are numerous or the underlying rock so close to the surface that the soil auger could not penetrate to the full depth—36 inches—generally reaching a depth of only 18 to 24 inches, except where the rock content was less than usual. The soil mantle in places, however, is often of unknown depth. The immediate subsoil and that below is as a rule quite compact, the color also changing with depth from yellowish to drab or farther down to a bluish color. The material is often sufficiently compact to give the impression of hardpan and holds water readily. Varying quantities of gravel and stones are found in the soil mass and scattered upon the surface. These stones consist of fine gravelly fragments, rounded gravel, cobbles, or angular and

subangular slabby pieces of rock. Small slate and shale fragments are often found, particularly where ledges of these rocks come close to the surface or protrude above it. Extensive areas where the fragments were of sufficient quantity were included in the Dutchess slate loam. The gravel and stones are more abundant in the subsoil, as the surface has been cleared of the larger stones and boulders. The removed stones have been used to build the field walls, being quite sufficient for this purpose. The north slopes of the hills are less stony, the stones not being sufficient to build the fences, and wire fences are more in evidence here than on the southern slopes. This absence of stones is explained by the fact that the ice sheet scoured over the north slope, carrying the stones over the hilltops and dropping them in the till on the south slope. The north slopes are generally the wettest, while the quantity of stone on the south slope assists drainage, making the soil drier.

As noted already, the Dutchess silt loam is the most extensive soil in the county, covering nearly one-fourth of the total area. It is found in all the towns except Pawling, though in some it is barely more than represented. The greatest development is diagonally through the central part of the county, the area increasing somewhat to the northeast. In the towns of Lagrange and Wappinger its extent is quite appreciable, while in the towns to the north of Wappinger, along the Hudson, the areas are smaller and not numerous. There are some small areas scattered throughout the slate belt from Pleasant Valley northward. These, as a rule, are irregular and not continuous, being broken by areas of other soils. This type is hilly and to some extent made up of ridges. The hills range from 300 to 400 feet in the extreme southwestern part of the county and along the Hudson to 1,200 feet or more in the northeastern part, the elevation gradually increasing to the north and east. The surface configuration of these hills and ridges is essentially that peculiar to glaciation in that they have been smoothed and rounded by the passing of the ice sheet and the deposition of glacial débris. The hills in most cases are elongated and more or less drumlinoid in shape. The north and south slopes are for the most part long and gentle, while the sides of the hills and ridges, especially in the upper parts, are often rather steep, but all are capable of cultivation. The higher hills and ridges in the county to the east and north have long, sweeping, smooth slopes.

The position of this soil on hills and ridges and their slopes allows of good surface drainage, but because of the imperviousness of the subsoil the slopes are often wet and swamp grasses are found growing on them. For such a crop as corn they require drainage. This can be accomplished by stone drains or in some instances by blind ditches. No doubt tiling would also prove beneficial on many of the

slopes. The moisture-holding capacity is sufficient to make the type as a whole comparatively wet and cold, and hence a late soil.

The Dutchess silt loam is largely of glacial origin. It is, however, closely related to the underlying rocks, in that it has been derived from the pulverization of similar rocks or rock of the same formation by the grinding and crushing of the ice sheet. The direction of the ice movement was along the rock beds and not across them, so that little intermingling occurred from the sides. The underlying rock, however, particularly where the soil mantle is shallow, has influenced the overlying soil to some extent. To this fact is due the slight textural and color variations in the soil mass. The underlying formation is the Hudson River group of rocks of Silurian age, consisting of a series of shales, slates, and grits in thin beds, alternating a great number of times, varying in composition and merging into one another by imperceptible degrees. Wherever these different rocks are found close to the surface the stone on the surface and in the soil mass will be found to be similar to the underlying rock.

Practically all of the Dutchess silt loam has been cleared and cultivated, and it is the principal farming soil in the county. It is considered a heavy soil, and on account of its moisture-holding capacity is well suited to grass and hay. It is used principally as pasture land for stock and for making hay, as dairying is the principal industry in the county. Timothy and redtop are the grasses most commonly produced on this soil, yielding about 1 ton per acre, but where the land is treated with barnyard manure and is reseeded more frequently the yields are much greater. Clover formerly made good yields, but at present is not so successfully grown. Other forage crops do well, and it would be very desirable to introduce at least one leguminous crop. Soy beans would doubtless succeed. Fair crops of corn, especially ensilage corn, are obtained, except on the higher elevations, where the climatic conditions are adverse. Wheat formerly made good yields on this soil. Rye is now grown universally, being valued for its straw, which is commonly sold for packing purposes. The grain is thrashed with the old-fashioned flail, in order to prevent injury to the straw from breaking. Oats are grown quite generally and make fair yields. Potatoes are produced on every farm and give returns of 100 to 150 bushels or more to the acre. Potatoes should be more extensively produced. Apples succeed and orchards are found on practically every farm, many of them being of commercial size. The apples produced in the county are grown mainly upon this type of soil. Although there are a number of commercial orchards, nevertheless the general practice is dairying, supplemented by apple growing. The varieties produced are the Baldwin, King, Rhode Island Greening, and a number of others. The stony slopes are desirable locations for orchards, as the drainage is usually good. A

northerly slope is preferred. Some peaches are produced, and there are a few orchards of commercial size in the central and southern parts of the county. Plums also do well, and the few plum trees seen on nearly every farm were bearing considerable fruit.

As a rule the farms on this type are kept in fairly good condition. This is made possible by the practice of dairying, by which large quantities of manure are made and applied to the land. Besides this, much commercial fertilizer is used. The farm buildings are good, and there are numerous outbuildings for housing stock, and indications in general point to a prosperous condition among the farmers.

The assessed value of the farms on this soil is next to that of the limestone lands. Values vary, depending upon a variety of conditions. The general value is quite high.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Dutchess silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17148, 17164, 18266.	Soil	4.0	7.4	3.8	8.7	4.6	60.6	10.9
17149, 17165, 18267.	Subsoil	4.2	8.0	3.9	9.4	4.0	57.3	13.2

DUTCHESS SLATE LOAM.

The surface soil of the Dutchess slate loam consists of light-brown or yellowish-brown, fine-textured shaly or slaty loam or silty loam, often quite gritty on account of the large content of fine sand, underlain by lighter colored or yellowish material of the same texture as the soil, or in some places by a plastic silty clay loam. Both the soil and subsoil, except in the more sandy phases, have, for the most part, a smooth and often greasy feel, imparted by small, thin, shaly or talcose flakes. In the soil and the subsoil and strewn upon the surface occur varying quantities of shaly and slaty flakes or chips or larger slabby pieces. In some places the larger pieces have been removed and used for building walls about the fields, there usually being a sufficient quantity for that purpose, so that here the remaining rock material is so small as to render the soil slaty or shaly rather than stony. To some extent rounded gravel and stones from glacial till are found intermingled with the material from the underlying rocks, but the quantity is not large except in occasional small areas. Here and there these fragments are very thin, flaky pieces, of pearly appearance, derived from the breaking down of talcose or hydro-mica slates, and these have a smooth, soapy feel. In other places the material may be coarser, more or less talcose, or it may be that the rock

is a coarser slate, either argillaceous or arenaceous, breaking into larger, more conspicuous fragments.

The fragments of sandy shales, and especially of the shaly grits, are irregular-shaped chips, rather than flakes. These fragments were of so varied a nature and so intermingled as to render separation on the basis of a difference in their character impracticable, but the resulting soils were apparently identical, or nearly identical, so that the present grouping may be considered satisfactory. Numerous outcropping ledges occur, making the surface almost as rough as that of Rough stony land; in fact, areas where the outcrop covered a considerable extent were included under Rough stony land.

The soil formation is shallow, varying from a few inches to about 24 inches or less in depth, and averaging from 15 to 18 inches. The surface soil is generally 6 to 8 inches in depth. The presence of organic matter in the soil makes it darker in color and apparently more loamy, and this difference in color marks its separation from the subsoil.

The Dutchess slate loam is an extensive soil type and occurs in all towns except those in the south and southeastern parts of the county. Its greatest extent is from the town of Lagrange and Pleasant Valley northward, where it occurs as a somewhat broader belt with numerous smaller irregular areas scattered over the county. The surface of the Dutchess slate loam is the roughest of any of the cultivable soil types of the county and has a topography distinctly its own and readily recognized. These areas are very slightly glaciated, at any rate not sufficiently to render the surface smooth, so that sharp rock ledge outcrops are common. Hills and ridges of uneven surface and of varying heights are quite numerous; the highest of the slaty hills reach 1,000 feet, but for the most part they are from 400 to 700 feet in elevation and rise from 200 to 300 feet above the general level of the county. The hills and ridges have in some places steep and in some precipitous slopes, but they are generally more or less cultivable. Between knolls and hills occur wet depressions filled with swampy vegetation.

Smaller bodies of Dutchess slate loam are occasionally found throughout the extent of the Dutchess silt loam. The occurrence of these bodies is usually upon the rougher and steeper slopes as well as on the sharp tops of hills and ridges.

The generally uneven and steep slope of the surface permits rapid surface drainage, and partings in the underlying rock also allow ready passage of water from the surface downward so that the soil is droughty, and during the summer months pastures and cultivated crops often suffer for need of moisture and yields are small, especially in abnormally dry seasons. Numerous springs occur, as well as large numbers of small brooks and creeks. Most of these carry water dur-

ing wet times, but during dry spells generally go dry or at best carry a very small quantity of water.

The Dutchess slate loam is probably mostly residual, though to some extent glacial, as indicated by the rounded gravel, stones, and boulders found in and upon the surface over practically every part of it. Yet the glacial material is probably only a small part of the soil mass as a whole. The underlying rocks giving rise to this soil, though closely related, are variable to some extent. They comprise a group of sedimentary rocks known geologically as the Hudson Group and consist of interbedded shales, slates, and grits. These formations cover the larger part of the county and have been more or less metamorphosed by pressure and heat, until the greater part has been changed to slate or has even approximated a schist. The shales are gritty or sandy to clayey and the slate gritty or clayey to talcose and chloritic, and some of the beds are more or less calcareous.

From the predominance of the slaty fragments the Dutchess slate loam is known generally as "slate" or "slaty" land. Its rough surface makes it in general a hard soil to till, otherwise the soil itself is easily handled. Where underlying ledges occur near the surface they are so weathered that the plow will cut through them, while with harder rocks the plow is stopped as in case of the limestone and dolomite soils. In places the number of fragments is so large that cultivation is interfered with.

The larger part of the "slaty" lands is used for grasses for hay and pasturage. This seems to be its best use. The hay crop is not nearly so heavy as on the Dutchess silt loam nor does pasturage hold out so well, and during dry spells the pasturage becomes very poor. Its advantage is the earliness of pasturage in spring, the result of better drainage conditions. The quality of the cultivated crops is good, but the average yields are low. A long-season crop like corn, with rare exceptions, makes poor yields, for just when the crop needs rain the most the soil is driest. Cereal crops that do not have to go through the summer do better, and rye and oats make fair yields. Probably the best crop, after grass, on this soil is buckwheat, some being grown on most farms.

Scattering apple trees and quite a number of successful orchards were seen growing on this soil. For success in this line the soil must be of sufficient depth and have good drainage. On the gentler slopes, especially the lower parts, trees, if given care and fertilized, return good yields. The fruit grown on such areas is desirable because it is usually well colored, firm, and of good flavor and keeping qualities. Pears and plums also succeed well.

In general the Dutchess slate loam is considered a light, thin soil requiring fertilization with either barnyard manure or commercial fertilizer, or both. A large proportion of it is really too rough to cul-

tivate without great difficulty, so that it is left in permanent pasture or in forest. Much of it has never been cleared and is covered by a forest growth, the best timber of which has already been removed. The timber consists of the deciduous trees of this region, with occasionally scrubby pines, and in the deep ravines or glens some hemlock. Chestnut and oaks are the predominating species and the cedar is common. The locust is also frequently found about cultivated fields. Much of this "slaty" land should be devoted to forestry, as such use will in the end bring better returns to the owner. Some of it could be left in pasture as at present, cultivating only the better lying fields. In the larger areas of the Dutchess slate loam the houses and barns are usually small and there are no large cultivated fields. Where not too far from the railroad, dairying or fruit growing is said to be the most profitable form of farming. Owners of this land not far from Rhinebeck are beginning to grow violets, generally as a side line in connection with dairying, and this is proving profitable. Where "slate" land occupies part of a farm composed in part of a better soil type, it affects the value of the whole farm very little, being utilized as permanent pasture land and woodland.

The assessed valuation of the slate land is about half that of other farm lands. On the market the farms bring the lowest price.

The average results of mechanical analyses of fine-earth samples of soil and subsoil of this type are given in the following table:

Mechanical analyses of Dutchess slate loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18261, 18263	Soil	7.5	11.4	4.0	8.0	8.1	46.0	14.0
18262, 18264	Subsoil.....	11.8	11.8	4.2	8.2	11.8	38.2	15.0

GLOUCESTER LOAM.

The surface soil of the Gloucester loam, to an average depth of 8 inches, consists of a light to dark-brown rather silty loam having a soft but slightly gritty feel. It contains without exception some mica, generally finely divided, varying in quantity but sufficient to be noticeable. In some places the flakes become much larger—an inch or more in diameter—and so abundant as to be seen several feet distant glistening in the sunlight. Where the content of this material is appreciable the soil has a soapy, greasy feel. The subsoil is a brownish yellow to light yellow in color and similar to the soil in texture though seemingly more sandy. It is, however, compact, and therefore retentive of moisture. The depth varies from 24 to 30 inches, where broken rock or bed rock occurs. The mica content in

the subsoil is greater than in the soil and the flakes usually larger. There are some fine rock fragments in the soil and subsoil, and some larger stones are encountered, but there does not seem to be a great quantity of the latter in the soil mass, as may be seen in road cuts, and the quantity on the surface was originally small. In general the stone content is much less than in any of the glaciated soil types.

The Gloucester loam occurs only in the towns of Pawling and Dover. Practically one large area, in which Rough stony land areas occur, mark its development. It occupies the tops and slopes of the highest ridge found east of the Pawling Valley along the Connecticut State line, a part of which is known as Quaker Hill. This ridge is broadly dome-shaped, has a rolling top with some secondary ridges, and the main slope is long and sweeping for a distance of several miles. The whole surface has been smoothed by glaciation, except the areas included under Rough stony land, and for the greater part, the slopes are gentle and capable of cultivation. The ridge rises about 700 feet or more above the Pawling Valley, its highest point on Quaker Hill being a little over 1,300 feet above sea level. The sloping surface allows good surface drainage, but the subsoil is so compact that it retains considerable water and the soil is spoken of as "wet and cold."

Of Glacial origin, the Gloucester loam, like the Gloucester stony loam, is influenced by the underlying rock probably even to a greater extent than the latter. It overlies a mica schist known as the Hudson schist, varying from a micaceous gneissoid rock on the one hand to a hard slate and nonmicaceous schist on the other. The breaking up of this rock has been the source of the mica in the soil, though the material may have been to some extent transported, so that the soil may not have been derived directly or entirely from the immediate underlying rock. The Gloucester loam is considered a heavy soil by the farmers. They say it works as a heavy soil and is "wet and cold." It gives large crops of hay—timothy, redtop, and clover. It will make 2 tons or more to the acre, and the better yields are obtained in the drier seasons, as the soil seems wet enough at ordinary times for grass. It makes fine pasturage, and the native grass sod is relatively permanent. Numbers of meadows have been sodded for long periods and are still productive, though this is in part due to frequent applications of barnyard manure.

Corn, as might be expected, does not do well except in the better drained places. On the higher situations the elevation is high for corn. On the slopes there are some apple orchards that are yielding well, but unless the soil is well drained orchards will not be profitable. The higher parts are not considered good locations for orchards. This soil would no doubt be greatly improved if drained by tile or by ditches. Recognizing the marked adaptation of the soil for grass,

the owners have nearly all their farms seeded down and follow dairying. The farms are large and well stocked, the dwellings and barns well built and commodious, and the region has the general air of prosperity. Good railroad facilities at Pawling, added to the general desirability of the land, cause farm values in this soil type to run quite high.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Gloucester loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16995, 17166.....	Soil	5.3	9.0	4.9	15.7	10.4	45.5	9.5
16996, 17167.....	Subsoil.....	4.7	9.5	6.2	16.9	10.1	41.8	11.8

GLOUCESTER STONY LOAM.

The surface soil of the Gloucester stony loam consists of 8 inches of a light or grayish-brown to dark-brown loam with a rather soft feel. Usually small quantities of finely divided mica are present, though to a much less extent than in the Gloucester loam.

The upper subsoil is a light-brown loam or silty loam, generally more sandy than the soil, changing with increasing depth to a yellowish color and heavier texture. The deeper subsoil, though not cemented as in a true hardpan, is compact and impervious. Like the soil, it contains some finely divided mica, and both in the soil and subsoil and upon the surface are scattered small stone fragments, rounded gravel, and bowlders of a gneissoid rock. In places, as on Chestnut Ridge to the west of Pawling Valley, the gneissic or granitic bowlders occur as masses, often several feet in diameter and weighing several tons. In fact, some of the areas represent cultivable soil bodies in a general Rough stony land area. In the valleys and on the lower slopes of the Fishkill Mountains the bowlders are not so large or so numerous.

The Gloucester stony loam is not an extensive soil type and is confined to the towns in the southern and eastern parts of the county. It is found only in the Fishkill Mountains, their continuation, Chestnut Ridge, and the glacial slopes of the hills in the Pawling and Dover valleys extending into Amenia.

It occurs on the tops and slopes of the mountains and mountainous ridges, the surface not being very rough except where bowlders are seen. On the glaciated slopes of the hills and low mountains the surface is smooth and not generally so stony as in the mountains.

On account of position it has good surface drainage, but the compact subsoil is more or less impervious to water; hence the soil is

rather cold and wet and is therefore better suited to grass than to cultivated crops. The Gloucester stony loam is largely a glacial soil derived from glacial débris. However, the area it covers was for the most part only slightly glaciated, so that the resulting soil probably differs little from a true residual soil, as the material of the underlying rocks has been merely broken off and crushed and probably not moved very far. The gravel, stones, and bowlders are of the same material as the underlying rock, which is of pre-Cambrian age and known as the Fordham gneiss. In the parts where glaciation was more active the topography has been smoothed and the soil mass compacted.

The Gloucester stony loam is a fairly productive soil and for the most part is better adapted to grass for hay or pasturage than to cultivated crops. Much of it can best be used for pasture land. The higher and stony areas on the mountains and ridges are rather poor and being far removed from the milk stations on the railroads dairying is not profitable. Buckwheat does well on these higher areas, but for corn and fruit the elevation is in the main too great. In lower situations these crops apparently do well. On the lower slopes in the towns of Dover and Tenmile River, where the soil is quite gravelly, tobacco gives good results, and some is grown on most of the farms where the soil and position are favorable. Two types of tobacco are grown, Havana seed leaf and Broad leaf, the former making cigar wrapper and binder and the latter cigar binder and filler. The reported yields range from 1,500 to 2,000 pounds per acre. The forest growth on this soil is principally chestnut, with oaks and other deciduous species represented.

The mechanical analyses of a fine-earth sample of the soil and subsoil of the Gloucester stony loam are given in the following table:

Mechanical analyses of Gloucester stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16997.....	Soil	4.8	7.3	4.3	13.8	15.2	46.9	8.5
16998.....	Subsoil.....	4.0	8.7	4.9	14.9	19.0	41.8	6.0

DUTCHESS STONY LOAM.

The surface soil of the Dutchess stony loam, to an average depth of 8 inches, consists of light-brown or yellowish-brown light silt loam or fine-textured loam, grading in some places to a rather heavy, fine sandy loam. The soil, though high in silt content, contains, however, appreciable quantities of sand particles, which, together with the fine gravelly fragments always present, make it granular and friable. Upon the surface and in the soil occur angular rock fragments of

varying sizes, usually not large, though there has been a sufficient quantity of the larger blocks to build walls about the fields. The rock fragments vary in quantity. Generally there is at least 20 per cent on the surface, though in some places it is completely covered by them. They consist of angular blocks or slabby pieces of thin-bedded sandstone or grit, more or less calcareous, or of a gritty shale or slate. Besides the fragments that come from or are similar to the underlying rock are found some rounded glacial gravel and boulders.

The subsoil is for the most part of texture similar to the soil, though it varies from a more sandy material to material decidedly clayey, the latter occurring where a more calcareous rock underlies. The color of the subsoil is generally yellowish, but in its lower parts often changes to slightly reddish or reddish yellow. The subsoil contains considerable quantities of fine rock fragments the size of fine gravel or larger, as well as angular blocks of the underlying rock. The bed rock on an average comes within 18 inches of the surface and on tops of ridges much nearer, so that the soil formation is only a few inches in depth, or, as is common, the rock outcrops, the ledges being so numerous in places as to warrant classification as Rough stony land. In general rock outcrops are a prominent feature in this soil.

The Dutchess stony loam covers a large area in Dutchess County, though limited to its western part, being the first upland type from the Hudson River. It occurs in a belt north from Poughkeepsie through the towns of Pleasant Valley, Hyde Park, Clinton, Rhinebeck, and Red Hook, with a detached area in Milan. This larger belt, though continuous, includes a number of areas of other soil types. Another area occurs in the towns of Wappingers Falls and Fishkill.

The surface of the Dutchess stony loam is very uneven and is marked by a series of ridges and hills generally low, but sometimes reaching an elevation of 200 or 300 feet above the general level. The surface of the ridges is marked by knolls here and there in which the underlying rock is generally exposed. On the lower situations, as in the valleys, the topography is characterized by disconnected rocky, irregular knolls, between which are generally found small swampy areas. The topography as a whole is so distinct that the type may be readily recognized by this characteristic alone.

The unevenness of the surface causes good surface drainage, while the granular character of the soil, the presence of stone fragments, and the partings in the underlying rock beds allow relatively free movement of the soil water, and yet the type is fairly retentive of moisture and of fertilizers. However, between the hills, as previously stated, are wet areas without outlets. When of sufficient size these have been mapped as a different soil type. Many small brooks and creeks traverse the areas of this soil.

The area covered by the Dutchess stony loam has been subjected to glaciation, but the work of the ice was not great. The soil seems to be largely derived from the underlying rocks or at least from similar rocks, the mass being transported, if at all, only a short distance. The material was pushed along and subjected only to slight grinding, as is evidenced by the angularity of the rocks on the surface and the absence of the finer glacial till or boulder clay. That glacial débris was dropped is shown by the presence of some glacial gravel. The underlying rock formation is sedimentary, consisting for the most part of strata of sandstone or a calciferous grit grading into more calcareous beds on one hand and into gritty shales and slates on the other. All are dark colored, of bluish or greenish cast in the unweathered rock and gray or greenish drab in exposed surfaces. While in places the rock is shaly, it is in others, as seen in outcropping ledges, almost massive or thick bedded.

Mechanical forces have entered largely into the formation of the Dutchess stony loam, though chemical action has had some influence, especially in the more calcareous beds. Where less stony or relatively free from rock outcrop the soil is easy to cultivate, but usually the stones and outcrops interfere more or less with farming operations. A large part of this type is still forested with deciduous trees, the most prominent species being oak, maple, and chestnut. Cedar is quite common, and the locust is often seen. For the most part it is not a strong soil, and much of it appears rather poor, although some parts make excellent pasture land. It is cultivated more extensively in the towns of Rhinebeck and Red Hook than elsewhere, and in the latter town is the principal fruit soil, where there are extensive orchards on it. It produces the Newtown Pippin as well as many other standard varieties of apples. Fruit succeeds best where applications of barnyard manure and fertilizer are made, as the soil needs fertilization, especially with organic manures, to make good yields. The apples attain a good size, and have fine color, flavor, and keeping qualities. This type also supplies largely the soil for the growing of violets in the greenhouses about Rhinebeck, the small rock fragments not being objectionable, although the larger gravel or stones are removed. Except where fruit is grown the soil is not generally desired as farming land, because of the rough surface, and few good farms were seen. It would seem that fruit growing could well be extended here, but, if not, the best use for the cleared land in sections suited for dairying is for pasture and hay. In other places it should be reforested.

The value of the farms in this type of soil varies greatly, so that it is difficult to state just what this land is worth. Some of it is as low as any in the county, while some areas bring good prices.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of the Dutchess stony loam:

Mechanical analyses of Dutchess stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18268, 18270.....	Soil	2.0	4.2	2.3	7.7	6.6	66.2	10.8
18269, 18271.....	Subsoil.....	5.0	5.6	2.9	8.5	9.3	60.0	8.8

HUDSON LOAM.

The surface soil of the Hudson loam consists of 8 to 10 inches of light or yellowish brown to dark-brown loam or heavy sandy loam. The soil has a coarse feel, which is imparted by the presence of coarse sand particles and fine gravelly fragments, but the greater part of the surface mass seems to be of finer texture, and in places is practically a silty loam or heavy loam. It is all more or less gravelly, approaching the gravelly loam texture, but the gravel is usually small and less than 10 per cent.

In the upper few inches the subsoil is similar to the soil, but it quickly changes to a gravelly sandy loam containing fine to small gravel, which increases in quantity and size with depth. Generally at less than 36 inches a more gravelly material is encountered, which continues to a considerable depth. On the whole the subsoil appears to be somewhat compact, so that it is more retentive of moisture than might be expected from its texture, and the soil is capable of withstanding ordinary droughts.

Areas of the Hudson loam occur with the other lacustrine soils along the Hudson River and extend back some distance from the river. The largest areas are in the towns of Red Hook and Rhinebeck. It occupies flat areas or terraces marked by few undulations, practically the only relief being draws and ravines eroded by the streams. The elevation of these terraces is about 200 feet above the Hudson River. In origin the Hudson loam is lacustrine, representing a shallow water sediment deposited under conditions of varying currents. It is also possible that some of the finer material from the adjoining upland may have been deposited later as overwash upon these plains.

Its level surface, the absence of stones, except small quantities of gravel, and the consequent ease of cultivation make it a desirable soil, though it is not as durable as some other soils. It is well drained, but fairly retentive of moisture and fertilizers and gives fair yields. It will grow good apples, small fruits, and truck crops, especially heavy truck, such as potatoes, tomatoes, and the root crops. It is an early soil, as might be expected, and is made highly productive by

heavy applications of barnyard manure and some commercial fertilizers. There are several commercial apple orchards on the Hudson loam, and the growers as a rule have met with success. The fruit grows to good size, is of fair quality, matures rather early, and is always highly colored, which is important with the red varieties. The Newtown Pippin can be produced on this soil, but it does better on some parts of the heavier soils.

Away from the immediate vicinity of the villages mixed farming is practiced. Dairying is carried on with general farming and fruit growing. Every farm has an orchard, the farmer realizing a considerable income from this source, especially in years when good fruit crops are obtained. Dairying is followed in order to have continuous employment and to keep the land in a productive state by the application of manure.

As a rule the owners of farms in this type of soil are in a prosperous condition. In the northern part of the county farms on this soil are assessed \$30 to \$50 an acre, but usually where bearing orchards are established the land can not be purchased.

The results of mechanical analyses of typical fine-earth samples of the soil and subsoil of the Hudson loam are given in the table below:

Mechanical analyses of Hudson loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18281.....	Soil	3.1	12.9	13.8	23.5	9.1	29.9	7.4
18282.....	Subsoil.....	6.1	16.7	17.2	28.6	11.2	13.9	6.6

HUDSON CLAY LOAM.

The surface soil of the Hudson clay loam consists of a light or yellowish-brown or brownish-drab heavy, silty clay loam, in which the silt content is very high. On the slopes the soil is shallower and somewhat heavier, and in the more level areas back from the river it is more silty. The depth of the soil ranges from 4 to 5 inches on the slopes to 8 inches or more in the more level situations. Probably the average depth is 6 or 7 inches.

A distinct line separates the soil and subsoil. The color, at first a light yellow or yellowish drab, quickly changes to a mottled drab or bluish drab and yellow. The texture, in the upper part a heavy, plastic silty clay, grades into a stiff, tenacious silty clay. At greater depths dark-blue clays occur. These clays are worked extensively along the river for brickmaking, especially across the Hudson.

The Hudson clay loam is the most extensive of the river or glacial lake terrace soils. Its greatest development is in the northern part of

the county in two areas contiguous to the river. The smaller area begins at a point at Staatsburg, following northward around Vanderburg Cove, and broadening out and extending back along Landsman Kill Creek toward Rhinebeck. The larger area extends as a band along the river, about a mile in width, from Rhinecliff north to Madalin, at which place it extends back from the river about 4 miles along the course of Stony Creek. Some small areas occur at a few places below Staatsburg, where the formation is covered by the sandy and gravelly soils deposited over it along the lower course of the river.

Judging from the remains of some parts of this formation it was evidently a flat terrace, with an average elevation of about 150 feet above the river. Since the formation of the terrace deep draws and ravines have been eroded in it. Nearer the river the result has been to form numerous ridges extending and sloping toward the river. Farther back there are flat areas, as, for instance, along Stony and Landsman Kill creeks. The Hudson clay loam resulted from deposition of sediments in glacial Lake Albany. The fineness of the material shows that it was deposited in deep, quiet waters, which at that time were next to the ice that filled the Hudson Gorge. This deposit was made all along the river, except where rocky areas stood above the water. In places the rocks were just low enough to allow shallow deposits of the clay. In the lower part of the county the clay sediments were finally covered by sandy and gravelly deposits so that the clays do not outcrop, although exposed in pits where brick-making has been carried on.

The Hudson clay loam, because of its heavy character and the imperviousness of the subsoil, is a cold, wet soil. The subsoil is always moist. When the surface dries it shrinks and cracks, and crops suffer from lack of moisture.

The upper part of the area along Stony Creek is generally flat and wet, and drainage is necessary. Other small areas are also wet, but along the river there is generally very good surface drainage. Tile drains would no doubt benefit much of this soil. It is retentive of any fertilizer applied to it, but being a cold, wet, intractable soil, it is not very desirable for general farming. It is, however, a strong soil and especially adapted to grasses, for which it is mainly used. It is said that when wheat was grown this soil produced large yields. It will grow apple trees on the better drained slopes, and even the Newtown Pippin has been successfully produced. The type is benefited by applications of lime, and the tilth is improved by plowing under roughage, such as coarse manures and grass-leguminous crops. Of the tree growth seen on this soil the cedar is most prominent, neglected fields growing up to this species, of which the trees attain good size.

The larger part of this soil type is not under cultivation. It is, however, cleared and has been cultivated at some past time. Along the river fine resident estates are located upon it, and here no attempt is made to farm it. Its value, because of its location, is very high, and none of it is on the market. It is valued highly because of the deposits of brick clay.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Hudson clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18287.....	Soil	0.0	2.1	1.4	5.2	6.4	63.2	22.5
18288.....	Subsoil.....	.0	1.0	.8	2.6	2.8	59.4	32.5

HUDSON SANDY LOAM.

The surface soil of the Hudson sandy loam consists to an average depth of 8 inches of a yellowish to light-brown medium sandy loam. In texture and structure it varies to some extent. In places it contains high percentages of the fine grades of sand approaching the texture of a fine sandy loam and in others coarser particles are more numerous, in which case it approximates a coarse sandy loam, but these places are small in extent. In structure the soil is generally coherent, holding together when pressed in the hand, but there occur small areas, such as low knolls or piles of sand in which the materials are loose and incoherent and reach to some depth without change of texture and structure. The subsoil is a yellowish medium textured sandy loam, apparently more sandy than the surface, as it lacks the organic matter generally present in the surface soil. It is, however, coherent to some extent, and in the main the texture and structure of the subsoil correspond to that of the surface material overlying it, the only change being the occasional admixture of gravel. It is noticeable that the larger grains are all rounded, showing plainly water action. The subsoil is underlain by clay deposits laid down at an earlier time.

The Hudson sandy loam is not extensive and occurs only in small areas along the immediate banks of the Hudson River. The largest areas are those near Rhinecliff and Staatsburg, but numerous small areas are found all along the river. The soil occurs chiefly as sandy slopes to the river, but at higher elevations it is marked by low knolls or by a rolling topography, with occasional level or nearly level areas. The drainage is good, as would be expected from its position, texture, and structure.

In origin the Hudson sandy loam is lacustrine, representing sediments deposited in glacial Lake Albany. The deposition evidently took place in shallow water and was laid down at a late stage of the lake upon the clay deposit, as the level of the water was lowered. It is an easy soil to work, but very little of it is cultivated. It produces fair yields of all crops grown in the county. It is, however, particularly well adapted to trucking and small fruits.

The following table gives the results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Hudson sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18275.....	Soil	0.1	2.9	13.2	41.2	15.6	18.3	8.4
18276.....	Subsoil.....	.1	1.1	6.5	49.4	23.2	12.6	6.8

HUDSON FINE SANDY LOAM.

The surface soil of the Hudson fine sandy loam, to an average depth of 8 inches, consists for the most part of rather heavy silty fine sandy loam, though varying in some places to a light fine sandy loam. In small areas or, rather, little hummocks where the material may have been wind-blown it is more nearly a fine sand, but even here it retains some coherency. The color of the soil ranges from light or yellowish brown to dark brown, the darker color indicating the heavier phases.

The subsoil consists of material similar in texture to the surface soil, but of lighter color, owing to a smaller organic-matter content. The lack of organic matter causes it to appear more sandy than the surface, and probably this is actually the case in the lower depths. It is generally very compact and occasionally the lower stratum carries some gravel, but for the most part the material is practically uniform to the underlying clay deposits. Because of the tendency to compact it makes a good molding sand, and in places it has been mined for that purpose.

The Hudson fine sandy loam is found along the Hudson River in numerous areas, the most extensive being south of Poughkeepsie. It is limited to the terrace section, or valley proper, of the Hudson, where its surface is rolling to hilly, with occasional fairly level areas. Its highest occurrence is on some of the hills, sometimes over 300 feet above the river, but for the most part it lies between the 100 and 200 foot contours. It is well drained, yet retentive of moisture on account of the compactness of the subsoil and the presence of the underlying impervious clays, so that it is not considered a droughty soil. In the spring the areas are wet and can not be worked early in the season.

It is of lacustrine origin, being a sediment laid down in glacial Lake Albany at a later stage than the clay deposits. A part of the material may have been derived through wind action.

The Hudson fine sandy loam, especially the heavier phase, is an easily cultivated productive soil. With the incorporation of organic matter it becomes quite loamy, and particularly well adapted to truck crops, both light and heavy, to small fruit, and even to tree fruits, such as apples and pears.

In the northern part of the county this soil is greatly desired for fruit and vegetables. It will produce the Newtown Pippin, as evidenced by one of the best orchards in the town of Red Hook. The red varieties of apples, such as the King, Baldwin, Northern Spy, and in fact most varieties, do exceedingly well. The fruits mature in good season and color well. It is not quite as early as the better drained gravelly types, so that fruit does not mature quite so early nor color quite so well, yet it is a more productive soil, is in greater demand, and brings a higher price.

Below Poughkeepsie the areas of this soil have practically all been dug over for molding sand, and lying close to the river where it is included in summer-residence estates, it has not been devoted to cultivated crops, but left in grass. It makes fair pasturage, especially where it overlies limestone at no great depth.

The results of mechanical analyses of typical samples of the soil and subsoil are given in the following table:

Mechanical analyses of Hudson fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18277.....	Soil	0.2	1.5	1.2	5.8	38.9	43.4	8.5
18278.....	Subsoil.....	.4	1.0	1.1	6.9	43.6	33.1	8.6

MERRIMAC LOAM.

The Merrimac loam consists of 8 to 12 inches of a gravelly dark-brown loam or silty loam of friable, granular character, underlain by gravelly material of lighter color, changing to yellowish and at an average depth of 24 inches or less becoming more gravelly or sandy and resting finally upon a gravelly or sandy substratum. Occasionally a little rounded gravel is found upon the surface and in the soil and subsoil, but the quantity does not exceed 10 per cent of the soil mass, for where more than this occurs it is included in the Merrimac gravelly loam.

The Merrimac loam is not an extensive type, the areas being generally small and associated with the Merrimac gravelly loam. It occurs on the gravelly terraces in the valleys, generally next to the

uplands, and occupies slight depressions. Some of the areas evidently were at one time swampy, but have been drained and made tillable. This type is probably due to wash from the adjoining areas laid down over earlier deposits of gravel, although to some extent it may be old alluvium. This soil is apt to be rather wet and requires drainage. It is an especially strong grass soil, making large hay crops and excellent pasturage. Where not too wet it will make good yields of corn, being especially desirable for producing a silage crop. The soil is inclined to be acid and applications of lime have always proven beneficial.

The results of mechanical analyses of a sample of the soil and subsoil, the latter down to the gravelly substratum but not including it, are given in the following table:

Mechanical analyses of Merrimac loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18296.....	Soil	3.4	10.4	7.2	10.0	8.0	46.1	14.8
18297.....	Subsoil.....	4.0	12.4	6.0	9.7	6.2	46.4	14.9

MERRIMAC GRAVELLY LOAM.

The surface soil of the Merrimac gravelly loam consists of a light-brown loam or heavy sandy loam, containing varying quantities of rounded gravel and a less proportion of flat, shaly gravel. In depth the soil ranges from 6 to 10 inches, with an average of 8 inches. The subsoil is a yellowish gravelly loam or heavy sandy loam, not differing from the soil in texture but carrying less organic matter. It has a more sandy feel and contains more gravel, from fine to coarse, the proportion increasing with depth, until at 18 to 24 inches very little fine interstitial material is found. The quantity of gravel on the surface and in the soil varies from 15 to over 50 per cent. The rock is mostly sandstone and quartz, with some shale or slate, the latter rarely rounded.

The Merrimac gravelly loam is found in all parts of the county, occurring along stream courses in generally narrow, irregular areas. The largest areas are in the Wappinger, Clove, Dover, and Amenia valleys, with a few rather small areas along the Hudson. It occupies the terrace or terraces above the first bottoms, along stream courses, and the areas are as a rule flat or at most only gently undulating, with occasional kettleholes in the larger areas. It is always found above the high-water mark of the streams.

The Merrimac gravelly loam owes its origin to glacial material or drift that has been modified by water. At the close of the Glacial epoch, when the ice was melting, the large volume of water issuing

from the ice front in the valley was loaded with gravel and earthy material, which was soon more or less assorted and deposited as terraces and gravelly plains. This material may have been reworked a number of times, and very often shows cross-bedding. There may also have been later alluvial deposits.

As might be predicted from the manner of its formation and position, the Merrimac gravelly loam is easily drained and at times even droughty. The soil is light and friable, is easily cultivated, and can be handled at any time, as it soon dries off after rains. It is not considered a strong soil, and is not retentive, but makes good yields when fertilizers are applied, and especially with liberal applications of barnyard manure. All the crops grown in the county are produced upon it, and it does particularly well in corn, potatoes, and heavy truck crops. It will also support a good stand of grass and rye, and oats are successfully produced at the present time.

It is considered a fairly good fruit soil, particularly in those areas which are not excessively gravelly and which have better moisture conditions. Apples are said to be of excellent quality as to flavor and color, but the fruit matures rather early and the keeping quality is not so good as those produced on some other soils. Fair yields are obtained, and are best maintained by barnyard manure, the use of cover crops, and green manuring. Pears, as well as apples, succeed upon this soil.

Although this soil is not as strong as some others in the county, it is esteemed for its position, smooth, level surface, and the absence of large stones or boulders. Some of the good farms of the county are located in whole or in part upon this soil type, and seem to have been in demand in the past for stock farms, and particularly for horse raising, as the conditions of drainage make them well suited to tracks for training purposes.

The average results of mechanical analyses of fine-earth samples of the soil and subsoil are given in the following table:

Mechanical analyses of Merrimac gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16993, 16999, 18293.	Soil	10.1	13.7	6.7	8.1	9.4	39.8	11.9
16994, 17000, 18294.	Subsoil	10.8	15.3	6.8	8.3	11.0	36.5	11.3

MERRIMAC GRAVELLY SANDY LOAM.

The soil of the Merrimac gravelly sandy loam consists of about 8 inches of a light gravelly loam or sandy loam. The surface material is light brown, changing to yellowish a few inches below. The soil has a distinctly sandy feel, owing to the presence of a relatively high

percentage of coarse sand, but contains over 30 per cent of silt and nearly 8 per cent of clay. The surface is covered with rounded gravel, generally not exceeding 2 or 3 inches in diameter and for the most part much smaller, and the soil not infrequently contains 40 per cent of such material. The quantity increases with depth and at about 12 inches the subsoil is largely composed of gravel of all sizes, with only a small quantity of sandy interstitial material.

The Merrimac gravelly sandy loam is found in most of the towns of the county, although not in very large areas. They are associated with the Merrimac gravelly loam, though they lie farther back from streams and next the upland, or on the sides of the valleys.

The surface of the Merrimac gravelly sandy loam is entirely distinct from that of any other type. It is marked by rounded knolls or hills with smooth slopes rising from 20 to 60 feet or more in height, with frequent kettle-hole depressions between them. The hills may occur singly or in a series, but they have no regular arrangement. The slopes are as a usual thing quite steep and difficult to cultivate, but they are smooth and no large stones or boulders occur on the surface nor are there any rock outcroppings. The mass is glacial débris, but unlike the material giving rise to the gravelly loam it has not been assorted by water, or, if at all, only in a few places. It may be morainal in origin.

The Merrimac gravelly sandy loam is a light, porous soil, not retentive of moisture, and on account of its liability to drought is not a desirable agricultural soil. It is cultivated to a slight extent but yields are small. It is poor grass land, though it will support a grass cover and generally forms a part of the permanent pastures. Little of it is forested.

The average results of mechanical analyses of samples of the surface soil of the Merrimac gravelly sandy loam are given in the following table:

Mechanical analyses of Merrimac gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16992, 18296.....	Soil	15.6	18.6	6.5	12.0	8.5	30.8	7.9

DOVER FINE SANDY LOAM.

The surface soil of the Dover fine sandy loam consists on the average of 8 inches of light-brown heavy or silty fine sandy loam or in places a light loam, generally containing considerable finely divided mica flakes. The soil for the most part is of a fluffy character, especially on the tops of the ridges where the underlying dolomite is

close to the surface. When wet it has a slick or greasy feel, imparted to it by the mica flakes. It contains fine gravelly fragments, and some glacial gravel boulders also occur, though nearly all the larger stones have been removed to build the field walls. Many outcrops of the underlying rock are found on the tops of the hills and ridges, and on the upper or steeper slopes.

The subsoil is a yellow, sometimes reddish-yellow, silty, fine sandy loam becoming generally more sandy with depth. Where the underlying rock lies within 36 inches of the surface or thereabouts, as it generally does on the ridges, the subsoil runs into a gray fine sand, which is nothing more than the disintegrated rock or dolomite. Where the rock comes near the surface the light fluffy organic mold merely covers this disintegrated rock material, but on the lower slopes, where the wash from above has collected, the depth is much greater than the soil profile—36 inches—and the material is more silty and darker colored. The subsoil, like the soil, contains considerable quantities of finely divided mica, which, when the quantity is very large, gives it a distinctive slick or greasy feel.

The Dover fine sandy loam is found in broken areas in the eastern tier of towns, and is not an extensive soil type. It is a valley soil and occurs on both sides of the valley in the eastern part of the towns indicated along Swamp River, Tenmile River, and Webatuck Creek. Its topographic features consist of hills and ridges rising rarely more than 100 feet above the valley floor. Near the streams the ridges and hills are low and sometimes merely disconnected knolls and knobs, while next the upland they become much higher. All are marked by an uneven surface, due to outcropping ledges of rock, and these are generally so numerous that cultivation is difficult. The slopes of the hills and ridges, particularly the upper parts, are very steep and in places almost precipitous and unfit for cultivation.

The uneven surface and nearness of the areas to the drainage channels afford ready surface drainage, and the texture and structure of the soil and subsoil permit the downward percolating of water. The soil is, in fact, inclined to be droughty, and grass, in dry spells, apparently burns out, but, as on the Dover loam, or "limestone land," it recuperates quickly after rains.

The Dover fine sandy loam is of glacio-residual origin and is derived from a dolomitic rock—the Stockbridge dolomite—of Cambro-Silurian age, metamorphosed more or less to marble. In the northern part of the county it seems to be less metamorphosed and approaches limestone, and in the town of Northeast the Dover fine sandy loam is displaced by the Dover loam. Interbedded with the dolomite are thin beds of dark-colored slate, which slightly influence the soil in their proximity.

This rock weathers rapidly—much more so than the contiguous rock formations—and to this, no doubt, is due the steep valley of which it forms the floor. It is a common occurrence to see the white sand upon the surface where a rock outcrop is disintegrating, and wherever the rock surface is met in the soil profile it is overlain by several inches of this disintegrating material or sand. At greater depths, where the formation is not affected by weathering, good building marble is quarried, and a large quarry is in operation in the town of Dover.

The Dover fine sandy loam is a light, friable soil and therefore in itself easy to cultivate, but the rough surface and rock outcrops limit cultivation to small areas less broken. It is, however, a productive soil and repays the effort of cultivation. Its best use seems to be for pasturage, the sod being strong and lasting, though dying down during dry hot spells. The soil is practically all cleared and is devoted largely to grass. Cedar is the characteristic tree growth of this soil. Aside from its agricultural value, it is held at high prices because of the probable occurrence of valuable marble veins.

The following table gives the results of mechanical analyses of fine-earth samples of the Dover fine sandy loam:

Mechanical analyses of Dover fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17001.....	Soil	2.4	5.3	3.4	13.0	22.1	43.5	5.1
17002.....	Subsoil.....	2.6	4.2	3.3	12.6	23.5	41.0	12.2

DOVER LOAM.

The surface soil of the Dover loam varies in depth from 6 to 10 inches, with an average of 8 inches. It consists of a light loam or silty loam, and in small areas of a rather heavy loam, varying in some places to a heavy silty fine sandy loam. The color is light or yellowish brown to dark brown, with a reddish or reddish-yellow cast in the heavier areas, and close to the rock being sometimes a rusty red. The soil has a soft feel, is friable, and has a granular structure. It also carries noticeable quantities of glacial gravel, as well as blocks of stone, largely limestone, of which there are numerous outcrops.

The subsoil is similar in texture to the soil, but becomes heavier immediately above the limestone rock, and here it is sometimes so silty and clayey as to be a plastic silty clay loam. The subsoil, although granular when wet, is more or less sticky. It contains considerable particles of fine to small gravel. Some limestone blocks,

and in places glacial gravel, are scattered through it, but as a rule the gravel is confined to the surface soil. The subsoil in some places exceeds a depth of 36 inches, but rock outcrops are plentiful, and the underlying limestone is often near the surface. The color of the subsoil is yellowish, changing with depth to a more or less reddish yellow and sometimes to red in the heavier places. It is this distinctive coloring of the subsoil that aids in distinguishing this from the other soil types in the county.

The Dover loam is found in all the towns in the county, except Pawling and Dover, though in some of the towns, such as Red Hook, Rhinebeck, and Hyde Park, the area it covers is small. The largest extent is in the towns of Fishkill and East Fishkill and following up the Clove Valley. Other areas occur more or less continuously in the valleys of Wappinger Creek and Fallkill Creek. The areas are not, as a rule, large and are interrupted by areas of glacial débris.

The Dover loam occurs in the lower parts of the county—the stream valleys—where it consists of hills and ridges. The former are smoothed to some extent, but on the whole, owing to outcropping ledges of limestone, the surface is uneven, in some places so much so that cultivation, except in small patches or fields here and there, is difficult. The extremely rough areas, however, have been included under Rough stony land. In general, the hills and ridges rise 40 to 100 feet above the general level of the valleys, and particularly in the southern part of the county some attain elevations of 200 or 300 feet, or over 700 to 800 feet above sea level. The areas of this type of soil are well drained.

The Dover loam appears to be largely of residual origin. The character of the soil and subsoil, particularly the latter, is similar to the soil material derived from limestone in other surveys. The limestone has, however, been glaciated in some situations and the surface soil, especially, is not very different from the true glacial types. Here glacial gravel is found. The loose boulders that now form the field walls were evidently broken off by the ice and strewn over the surface, but that they have not been subjected to much grinding is shown by their angularity. The limestone varies from light gray or blue to dark blue, and while the greater part of it is massive, a considerable part is brecciated. It occurs in strata interbedded with the shales and slates of the Hudson River group of rocks and is of Cambro-Silurian age. The rock is hard and comparatively resistant to weathering, as evidenced by the outcrops. In general this class of rocks is highly soluble and the soil is the insoluble residue left from the solution of large masses. The process of formation of this soil has thus been largely chemical.

The Dover loam is known locally in the county as "limestone land" and is a highly productive soil for all the crops grown in this county

and especially prized for pasture. The soil is friable and easily worked, except where the rock outcrops or lies too close to the surface. It will produce more corn than any upland soil in the county, does especially well when planted to the small grains, and will give large crops of hay. It is rather drouthy and in dry spells crops suffer for want of moisture, but whenever rain falls they recuperate quickly and in an incredibly short time grass, for instance, although apparently burnt out, starts growing and takes on a good color. Over the greater part of this type, where a mowing machine can not be used because of the unevenness of the surface and the presence of rock outcrops, its best use is for pasturage for stock. In addition to the general farm crops this soil seems also fairly well adapted to fruits, and large crops of apples are produced.

The Dover loam maintains its productiveness better than any soil in the county and is the most responsive to good treatment. Applications of barnyard manure, commercial fertilizers, or of almost any fertilizing material, together with good cultivation, are always rewarded by greatly increased yields. Lime has always been found beneficial and is obtained cheaply from the local limestone beds, though the practice of applying lime is not general.

Land of this type is almost all cleared, and only some of the rougher spots remain in forest. Cedars are of common occurrence and seem particularly partial to this soil, some areas being entirely covered by them. Locust is commonly found, especially along the walls surrounding the fields. Some of the best farms in the county are wholly or in part "limestone land," and the owners as a rule are prosperous and have good dwellings, barns, and outbuildings. The farms are usually well stocked. Though the greater part of this soil is away from the larger towns, it has a high assessed value.

In the following table are given the average results of mechanical analyses of fine-earth samples of the soil and subsoil of the Dover loam:

Mechanical analyses of Dover loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17285, 18259.....	Soil	2.7	6.6	4.2	11.8	9.5	52.3	12.8
17286, 18260.....	Subsoil.....	1.8	6.7	4.3	12.5	8.1	52.4	13.8

PODUNK FINE SANDY LOAM.

The surface soil of the Podunk fine sandy loam consists, on the average, of 8 inches of light to dark-brown fine sandy loam, rather silty, and containing a high percentage of very finely divided mica, the latter imparting a more or less greasy feel. The subsoil is a

yellowish fine sandy loam changing to fine sand, which may rest on a gravelly stratum at less than 36 inches below the surface. Like the soil, it is very micaceous, the particles being finely divided.

This is the least extensive soil in Dutchess County, there being only two small areas, amounting to less than 1 square mile. They are found on one of the small tributary streams of the Swamp River in the southeast corner of the county, in the town of Pawling, and occur as bottom-land areas and are of alluvial origin, being deposits of the fine sandy wash from the slopes, left by the stream in its flood plain. Both texture and structure favor drainage, but its low-lying position subjects it to frequent overflow. It is an easily cultivated and productive soil and gives good yields of grass and of the cultivated crops, especially corn. The same soil is found in extensive areas along the Connecticut and Merrimac rivers in New England, where it has been previously mapped.

RHINEBECK LOAM.

The surface soil of the Rhinebeck loam, which has an average depth of 8 inches, varies from a light silt loam or silty loam to a light loam or heavy fine sandy loam. The subsoil, too, is variable, but consists for the most part of light silty loam to silt loam. It is in general of yellowish color, but often mottled yellow and drab, especially in lower depths. It exceeds 36 inches in depth—the limit of the soil profile.

Soil of this type occurs along Landsman Kill, in the town of Rhinebeck, extending into the town of Red Hook, and covers only a small area. The areas lie less than 20 feet above the stream courses, and have a rolling to nearly flat topography, the relief being sufficient to afford fair surface drainage.

In origin the Rhinebeck loam is uncertain, though it seems to have resulted from the intermingling of the materials that go to make up the Hudson clay loam and Hudson fine sandy loam, modified by later alluvial material. It is an easy soil to till and is fairly productive of all the crops that are grown in this section. Corn does well, and some cabbage seen growing on it indicated that it is a good soil for that crop. The lower lying parts are best adapted to grasses for hay and pasturage. It is all cleared and is or has been under cultivation.

The results of mechanical analyses of samples of the soil and subsoil of the Rhinebeck loam are given in the following table:

Mechanical analyses of Rhinebeck loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18298	Soil	1.2	2.7	2.0	9.6	6.2	63.1	19.7
18299	Subsoil	.3	.9	.8	3.6	4.4	72.9	16.4

HUNTINGTON SILT LOAM.

The surface soil of the Huntington silt loam consists for the most part of a rather heavy silt loam of a light or drab color, but varies to a yellowish-brown light silt loam or silty loam. It averages about 8 inches in depth. The subsoil is more variable, but generally is a yellowish, yellowish-drab, or purplish-yellow silt loam. In some of the lower situations it is heavier, being a silty clay loam or even a silty clay. It is more or less plastic, the heavier phases being often mottled yellow and drab. This sort of subsoil is spoken of as clay foundation by the farmers. In the lower depths, generally at less than 36 inches from the surface, it becomes sandy and sometimes is underlain by a compact, fine to medium, drab-colored sand or by a gravelly stratum.

The Huntington silt loam occurs in all parts of the county, as small, rather narrow first-bottom areas along streams, and is usually subject to overflow. Some of the areas, however, occur at the heads of streams or as depressions in drained meadows. It represents flood deposits of the materials washed from the immediate slopes and mixed with that brought down from farther upstream. It is therefore somewhat variable. Lying so low and close to the streams it is more or less saturated during wet spells, but the higher parts have good drainage and are well adapted to corn. Practically all the areas mapped are capable of growing cultivated crops. Its best use, however, is for grasses for hay, and for pasturage it is not excelled by any soil in the county, as the moisture conditions are favorable to a continuous and heavy growth of the pasture grasses.

At present the greater proportion of this soil is either devoted to hay or pasturage, and its occurrence in a farm greatly enhances the value. It is highly prized, but owing to limited development it really has little influence on farm value in general.

The results of mechanical analyses of samples of the Huntington silt loam are given in the following table:

Mechanical analyses of Huntington silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18289.....	Soil	0.2	1.0	0.6	6.2	15.0	65.1	11.0
18290.....	Subsoil.....	.0	1.0	.8	2.6	5.1	72.7	16.9

ROUGH STONY LAND.

Rough stony land includes all those areas too steep and stony for cultivation, but which are of some value for forestry or, if cleared, for pasturage. Occasional small patches of soil occur that may be

cultivated, and these would be shown as some other type of soil if it were not for the fact that they are too small to be shown on a map of the scale of 1 inch to the mile.

In Dutchess County the areas of Rough stony land are found on the tops and slopes of the mountains, on the slopes of hills and ridges, and occasionally on rocky knolls in the valley floors. The areas occur in all parts of the county, and the total extent is quite large. The most prominent development is in the southern part of the county, where areas occur covering the Fishkill Mountains, continuing on Chestnut Ridge and the mountains along the eastern boundary. In some places the topography is quite rugged. The areas scattered over the remainder of the county are generally small and occupy steep slopes where rock outcrops are numerous. The type includes all the rock formations, but the greatest development is in the pre-Cambrian formation of gneiss and granite. In this formation huge boulders are commonly strewn over the surface, and rock outcrops are plentiful. The boulders are subangular to rounded, showing the work of ice action. In the dolomite, limestone, and slate series of rocks the outcropping ledges are the prominent feature, not of sufficient extent to class as Rock outcrop, but of sufficient steepness of slope or uneven surface to preclude cultivation. There is, however, enough soil between the outcrops to support a growth of grasses or forest. Here the work of glaciation was feeble, resulting merely in removing the preglacial soil mantle, if there was one, and in depositing only a small quantity of glacial débris here and there, so that the interstitial soil is doubtless largely residual and derived from the immediate rocks. The agricultural value varies. Areas in which dolomite and, particularly, limestone are found are highly prized because of their value as pasture lands. For the most part, however, the areas of Rough stony land are in forest, consisting chiefly of oak and chestnut. On the mountains occur some black pine and other scrubby growth and in the ravines hemlock, while on the dolomite and limestone formations cedar is the predominant growth, and on cleared areas locust is common.

The general value of Rough stony land is very low, but where small areas are included in a farm the value of the whole is not greatly affected, such areas being considered as woodland or rough pasture. These uses are the best to which Rough stony land can be put, and forestry in particular would be remunerative. In a few favorable locations where the soil is sufficient orcharding might be made profitable.

MEADOW.

In Meadow is included low areas lying in depressions or along stream courses and too wet to cultivate unless drained. Such areas

usually support a growth of water-loving grasses, shrubs, and trees, or in the wetter parts rushes.

The soil material varies widely, but consists mostly of drab-colored light to heavy silt loam. The subsoil is variable, but, like the soil, is most often a heavy silt loam, though ranging from a typical silt loam to a sandy silt loam. All these several phases of the subsoil are grouped under the local term "clay foundation." The subsoil is more or less impervious, and the surface is wet practically throughout the year. The lower lying parts of areas are often more or less mucky, especially along Swamp River, in the Dover and Pawling Valley, in the eastern part of the county. Some areas are peaty. Some of the land included in Meadow is really Swamp, and some smaller areas of Muck occur, but these were too limited to warrant separation. Of the tree growth, elm and soft maple are the most prominent, and along the upper course of Webatuck and Nortse creeks, in the northeastern corner of the county, some tamarack is found.

The Meadow is distributed generally over the county in long, narrow areas, the largest occurring along Swamp River and Webatuck, Nortse, and Wappinger creeks. These areas are due without exception to obstructed drainage caused by glaciation.

Agriculturally these areas at present have very little value, as they are usually too wet to be cultivated. Some swamp grasses are cut, and the drier portions make excellent pasturage and in some cases good hay crops in dry seasons, but this is the extent of its present use. The mucky areas should be utilized for such crops as celery and onions. There are valuable areas that could be reclaimed by drainage, but in the majority of cases drainage is not feasible or at least is so difficult that the expense would be quite high.

MADELAND.

The term "Madeland" has been applied to small areas along the Hudson River, where extensive docks have been built, and to the large clay banks, quarries, and iron mines, where a sufficient area has been dug over to warrant mapping. Madeland has no agricultural value.

ROCK OUTCROP.

The Rock outcrop represents areas where outcropping ledges occupy so much of the surface that the land is of no agricultural value whatever. In places such areas are steep precipices; in others they are rough tops and slopes of mountains. The tree and shrub growth is sparse and stunted, hemlock being most prominent in the ravines, and black pine, scrubby oaks, and chestnut, with huckleberry bushes, in other parts. There are only a few areas of Rock outcrop. The largest of these is on Breakneck Ridge, and other areas are found on the tops and higher parts of the Fishkill Mountains in the southwestern part of the county and on the mountains in the extreme northeast corner.

SUMMARY.

Dutchess County is situated in eastern New York along the east bank of the Hudson River. It comprises an area of 511,872 acres, or approximately 800 square miles. Its surface is uneven, the topography being hilly to mountainous. The surface configuration has been modified more or less by glaciation. The elevations range from sea level on the Hudson to over 2,300 feet on the highest mountain. The county is drained by a number of creeks, which empty into the Hudson. The eastern part of the county drains into the Housatonic River, in Connecticut.

Poughkeepsie, the county seat, situated in the central part of the county, on the Hudson River, is the largest city, with about 25,000 inhabitants. It has important manufactories and is a railroad center and shipping point for the river traffic. Fishkill-on-the-Hudson and Matteawan are the next in importance, having together a population of 10,000.

The county has exceptionally good transportation facilities. There are a number of different railroads and on the Hudson River several steamboat lines.

Farm products meet with ready sale in the residential and manufacturing towns of the county. The important outside market is New York City, where the greater part of all the products shipped is disposed of.

The settlement of Dutchess County began about 1685. The settlers were mainly Dutch, with some of English descent from New England and a few French Huguenots. The settlement and development for the first half century was slow, but after that it was rapid, and by the time of the Revolution the county was important in population, manufacturing, and agriculture.

The chief specialty in the county is dairying, which became of importance in the middle of the last century, coincident with the development of railroad transportation, and the important crops are mainly those necessary to the dairy industry. Before that cereal production had been the leading branch in the western part of the county and stock raising in the eastern. Apple production now is also an important industry, supplementing dairying on many farms.

Crop rotation is practiced but not followed closely. It consists of corn one year, followed by small grain one or two years, and then grass, cutting it for hay for two or three seasons, and following that with pasture for indefinite periods.

Excluding the nonagricultural lands, seventeen types of soil were encountered in the county. These follow rather closely the character of the rock with which they are associated, although more or less affected by glaciation. The soils associated with the metamorphic

crystalline rocks are included in the Gloucester series. Those from the limestone and dolomites are in the Dover series, from the former a loam and from the latter a fine sandy loam. These are very productive soils and highly prized.

The soils associated with the Hudson River group of shales, slates, and grits form the Dutchess series and consist of a silt loam, a stony loam, and a slate loam. The silt loam is most largely of glaciated material. All the foregoing upland soils may be classed as glacio-residual in origin.

In the stream valleys occur gravelly types from glacial debris removed by water and deposited. They are included in the Merrimac series, a group of soils occurring in the valleys throughout New England. Along the Hudson is a series of soils of glacial lake or lacustrine origin laid down as sediments in Lake Albany, a body of water existing at the close of the Glacial period. They have been included in the Hudson series and consist of a clay loam, loam, fine sandy loam, and sandy loam. Two soil types of recent alluvial origin are found along streams. They are not extensive, but are highly productive soils.

The adaptation of the soils to crops is generally recognized. All the upland soils are suited more or less to grasses, the stony soils not being quite so strong, though earlier. The limestone lands are most highly prized for grasses, for hay, and pasturage. Alfalfa would doubtless succeed on these calcareous soils. Corn also does best on the limestone soils of the uplands. Where the location and exposure are favorable all the upland soils are adapted to apple culture. Of these soils, the Dutchess silt loam and Dutchess stony loam are the most extensively used for this purpose, large orchards occurring on them. The "slaty lands" are also used to some extent. Apples are also grown on the gravelly and sandy terrace soils, where the fruit yields well, colors highly, and has a good flavor, but matures earlier and has, therefore, not the good keeping qualities of apples grown on the later upland types. The sandy and more loamy soils of the valleys and along the Hudson would be well adapted to truck crops, but they are not used to any appreciable extent for this purpose.

The Dutchess stony loam seems to have a peculiar adaptation to violet culture, though some of the other soils are used successfully for this purpose.

The farmers have generally good houses and barns, and the homes have many modern conveniences. The county roads are excellent, enabling the farmer to reach railroads and other points easily. Telephones and daily rural mail service are available. With the keeping of summer boarders, which has become an important business, the income of many has been augmented.

SOIL SURVEY OF THE JOHNSTOWN AREA, PENNSYLVANIA.

By CHARLES J. MANN and HOWARD C. SMITH.

DESCRIPTION OF THE AREA.

The Johnstown area is situated south and west of the center of the State of Pennsylvania. It includes the southern half of Cambria and Blair counties and a small part of the northern portion of Bedford County. The top of Tussey Mountain separates the area from Huntingdon County on the east, while Westmoreland and Indiana counties lie to the west. Somerset County touches the area at the south-west corner. Except for irregularity at the south corners, the area in shape is an oblique parallelogram. It contains 457,216 acres, or about 714 square miles.

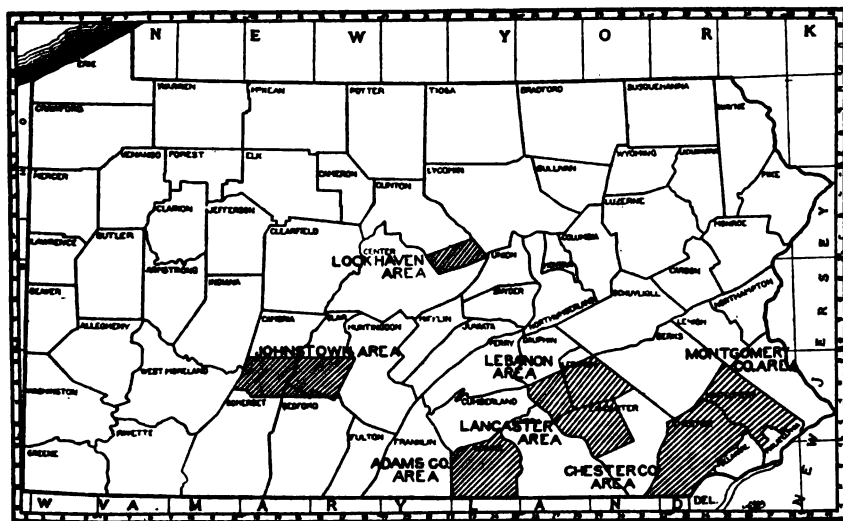


FIG. 2.—Sketch showing location of the Johnstown area, Pennsylvania.

The base map used was made by the United States Geological Survey and published as the Johnstown, Ebensburg, Hollidaysburg, and Huntingdon quadrangles. On these sheets the area is located between $78^{\circ} 10'$ and 79° west longitude and $40^{\circ} 15'$ and $40^{\circ} 30'$ north latitude.

The entire area is situated in the central part of the State of Pennsylvania, in the Appalachian province, which in this area has three well-marked natural divisions. These are the Allegheny Plateau in

the western part, the Appalachian Valley region in the eastern part, and the Allegheny Front, which passes through the center of the area in a general northeast-southwest direction.

The characteristics of a plateau can be recognized only in a general way and only when the district is viewed from a high point, because severe erosion has caused a very hilly, uneven, and in some places even a rough topography. The Allegheny Front is the boldest physiographic feature in the survey and forms a high escarpment, facing toward the east, through which streams have cut deep, precipitous ravines. The Appalachian Valley region is made up of successive valleys and mountain ridges.

East of the Allegheny Front is the shale valley of the Juniata River. This is separated from the limestone valley of Morrisons Cove by Dunning, Short, Loop, and Lock mountains. East of the cove and on the eastern edge of the area lies the mountainous ridge known as Tussey Mountain.

The crest of the Alleghenies, which follow closely the Cambria-Blair county line, forms the watershed of the principal drainage systems of the eastern United States. Two stream systems are well developed in the Johnstown area. The main stream in the eastern system is the Juniata River, which receives the drainage from the east side of the Allegheny Mountains through small streams, and from the southern end of Morrisons Cove through McKees Gap. At the foot of Short Mountain it turns abruptly to the northeast and receives the drainage from the Horseshoe Curve section through Beaverdam Creek at Hollidaysburg. It continues thence in a general northeasterly direction through Lock Mountain Gap, where it is joined by Clover Creek, and flowing north leaves the area at the base of Tussey Mountain.

The western system is not so simple. The Little Conemaugh rises near Cresson and flows southwest, receiving the drainage of the western slope of the Alleghenies and the region north. At South Fork, South Fork branch joins it from the northwest. At Johnstown it unites with Stony Creek, a stream of nearly equal size, and maintains the course of that creek to the northwest, passing out of the area through Conemaugh Gap. A small district north of Cresson drains north, but west of Ebensburg the South Fork of Blacklick Creek forces a passage westward through the Laurel Ridge, draining the rough northwest corner of the area.

There seems to have been no permanent settlement in the area until about 1756, when Stephen Frank located at Frankstown, in Blair County. Subsequent settlements were comparatively slow, because the Indians were a constant menace. A permanent white settlement was made at Moxhom, Cambria County, in 1774. It is said there were settlers in Morrisons Cove as early as 1749, but it is probable that no

permanent settlements were made there until about 1800. The pioneers of Cambria County were mainly Scotch-Irish, although there were some English and Welsh. Morrisons Cove was largely settled by Germans.

When the development of the natural resources of the region, such as the mining of iron, coal, and lead, and later the working of the clay and limestone deposits, was begun, there followed a rapid increase in population, which centered in the cities of Johnstown and Altoona. The rural population also increased rapidly, but not in proportion to the cities.

Martinsburg, in Morrisons Cove, is the only strictly agricultural town in the area. Ebensburg derives most of its income from agricultural products, but as it is the county seat of Cambria County and a delightful summer resort, it has been materially benefited from outside sources.

Johnstown is the largest city in the area and most of its inhabitants find employment in the various industries. The claim is made that it has doubled in population during the last decade. Several small mining towns are situated on the Pennsylvania Railroad between Johnstown and Altoona, which lies just outside the area. Hollidaysburg is the second town of importance in the area, and is a railroad town receiving the agricultural products from a large territory. Williamsburg is the headquarters of the limestone industry, although manufacturing and agriculture are also important.

The rural districts in the vicinity of the larger towns are fairly thickly populated, although in some parts lumbering camps are the only dwellings.

In the larger towns there is such a demand for truck crops and all kinds of farm products that nearly all of the produce is consumed in the towns and little is shipped outside the area.

Although the marketing of crops is attended by more or less difficulty, owing to steep roads and in many cases long hauls, the main roads are kept in good condition through the use of crushed rock, which is everywhere obtainable. Toll roads are still in existence in certain localities, but these are not altogether popular and will doubtless be done away with in the near future.

The area is traversed by the main line of the Pennsylvania Railroad and its many branches and by a branch of the Baltimore and Ohio Railroad to Johnstown.

CLIMATE.

The climate of this section of Pennsylvania is moderate and healthful and suited to a wide range of crops. The temperature rarely exceeds 100° F. in summer or falls below 15° F. in winter. At Johnstown, which has an elevation of 1,177 feet, the average annual tem-

perature is 51.3° F., and at Cassandra, near the center of the area, 47.8° F. This difference of 3.5° is probably caused by the difference in elevation of 623 feet. Cassandra has a normal growing season of one hundred and fifty-one days.

General farm crops, with the exception of corn grown on the higher levels, which is sometimes caught by frosts, mature in this section without injury. An early maturing variety of corn which would insure a crop each year should be sought for. Owing to the fact that corn suffers in this way, some of the higher lands which were once cultivated to it have now been abandoned. Late frosts in spring sometimes injure fruit buds, or wheat and grass in the heavy, undrained soils may be damaged by freezing unless protected by a covering of snow. On the eastern slopes, however, fruit seems to do very well.

The area has abundant rainfall. The table below shows about 15 inches of precipitation from December to March, inclusive. The annual precipitation at Denny, Everett, and Huntingdon is given as 45.11, 41.43, and 42.38 inches, respectively.

During the growing season, from April to August, an average of 20.87 inches of rain falls. This is ample for all crops, and droughts are of rare occurrence. If the planting of spring crops is retarded, buckwheat is planted in June, so that the farmer's income is not materially lessened. Stock can be pastured during at least half the year.

The following tables give the normal monthly and annual precipitation and temperature at Johnstown, Altoona, and Cassandra, and the dates of the first and last killing frosts at these places for seven years:

Normal monthly and annual temperature and precipitation.

Month.	Johnstown.		Altoona.		Cassandra.	
	Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.
	°F.	Inches.	°F.	Inches.	°F.	Inches.
January.....	29.2	4.00	25.3	2.84	25.4	3.19
February.....	29.1	3.97	24.1	2.58	23.8	3.17
March.....	39.7	3.91	38.4	4.17	36.9	3.98
April.....	49.7	3.81	47.7	3.32	46.5	3.16
May.....	61.4	4.43	59.9	4.06	59.2	4.58
June.....	69.7	5.11	66.7	3.99	65.8	4.70
July.....	78.2	4.71	72.0	4.48	69.8	4.84
August.....	71.1	4.46	69.6	3.46	67.5	3.52
September.....	65.0	3.35	62.9	2.60	61.6	3.04
October.....	58.6	2.71	52.3	2.90	50.0	2.74
November.....	41.5	3.36	39.9	2.55	38.5	3.02
December.....	32.6	3.58	28.8	2.90	29.1	3.14
Year.....	51.3	47.40	49.0	39.85	47.8	43.08

Dates of first and last killing frosts.

Year.	Johnstown.		Altoona.		Cassandra.	
	Last in spring.	First in fall.	Last in spring.	First in fall.	Last in spring.	First in fall.
1899.....	Apr. 11	Oct. 1	Apr. 17	Oct. 1	Apr. 11	Oct. 1
1900.....	May 6	Oct. 17	May 6	Oct. 17	May 5	Sept. 19
1901.....	Apr. 12	Oct. 4	Apr. 17	Oct. 4	May 14	Oct. 2
1902.....	May 29	Oct. 15	May 29	Sept. 15	May 10	Oct. 22
1903.....	Apr. 24	Oct. 28	May 2	Sept. 29	May 5	Sept. 29
1904.....	Apr. 17	Sept. 22	May 12	Sept. 22	May 12	Sept. 21
1906.....	May 11	Oct. 11	May 10	Oct. 8	May 10	Oct. 8
Average.....	Apr. 29	Oct. 10	May 5	Oct. 1	May 5	Oct. 2

AGRICULTURE.

The early settlers found the soil well adapted to corn, wheat, and other grains, flax, and potatoes. Corn was the favorite crop and hominy (hulled corn) was a staple food until the first gristmill was established near Summerhill in 1801. Growing flax and wool from which to make homespun cloth was early an important industry. In fact, the first farmers produced nearly everything they needed.

Corn, it is said, in the early days yielded 100 to 125 bushels in the ear, wheat 30 bushels, and potatoes 250 bushels. The first grain crops were cut with a sickle and later the cradle came into use and is still employed in the mountainous parts. The advent of the mower and reaper gave an impetus to agriculture, and the surplus crops were exchanged in markets farther east for articles which could not be supplied at home. The opening of State roads was of great benefit to agriculture also.

The principal occupation of the inhabitants, however, was lumbering, farming being secondary until within the last thirty years. Since then the increasing scarcity of timber, the development of new markets, and the establishment of great industries has led to the practice of general agriculture on a larger scale. Market gardening is also carried on to a large extent. The valuable mineral rights on many of the farms have been sold, and the money received from this source has improved the financial condition of the farmers.

Formerly many sheep were raised, but the decline in the price of mutton and wool, together with the ravages by dogs, has caused a lack of interest in this industry, and now, even with higher prices, sheep raising is on the decline. About 1890, on account of low prices, the breeding of choice horses received a check, although many carloads of horses of ordinary grades are still raised and sold for use in the cities. Some western horses are brought in each year. With the exception of some blooded Percherons there are no particular breeds raised at the present time, the farmers being content with heavy grade horses of good quality.

Dairying has always been followed, though not as a specialty, except in Morrisons Cove and vicinity, where there are many dairy farms. The cows are of various breeds, with a predominance of Jerseys. Transportation has developed the milk industry near the towns and shipping centers, the farmers either delivering milk to a skimming station for pasteurization or shipping it direct to the cities. The milk is often bought according to its butter-fat content, and this fact should give an incentive to the breeding of high-grade cows yielding rich milk. Milk usually retails at 8 cents a quart in summer and 9 cents a quart in winter. Doubtless dairying will be conducted on a more scientific basis, as silos are becoming general and the tendency is toward improvement in breeding and management.

Raising cattle for beef has never been an important industry and not enough is supplied to meet home demands. Since beef has become more expensive some farmers have bought steers in Pittsburg in the fall, fed them until spring, and sold them at a good profit, in addition to utilizing their coarse fodder and obtaining more manure. On farms remote from markets which have good pasture the production of beef cattle is to be recommended.

Enough hogs have always been kept to supply home needs, the number depending upon the supply of grain available and the number of cows on the farm. Grade Chester Whites predominate, but there are many Berkshires on the farms in the western part of the area. Although few farmers raise more than a half dozen pigs, the sale of spring-weaned pigs is a growing industry, as the villagers in mining towns usually keep one or more.

Every farm supports a considerable flock of poultry. Eggs are always in demand and find a ready sale at remunerative prices. The large urban population consumes nearly all the poultry products, and very little is shipped to outside points.

Many new orchards are being planted. Apple and peach orchards predominate. Grapes are produced for local consumption. At present the demand for grapes can not be supplied. The common varieties of apples are the Summer Rambo, Winter Rambo, Astrachan, York, Baldwin, and Gravenstein. Plums are grown near Hollidaysburg, and quinces and cherries seem to do well. The number of pear orchards is increasing. Raspberries and blackberries are grown for domestic use, and the soils are well suited to their production.

Market gardening has been greatly stimulated by the demand from the large towns in the area, where manufactures of various kinds are conducted. The development of the coal mines, quarries, and the steel industry has done much to bring about this demand. As a result the majority of the farmers plant from a fraction of an acre to several acres of truck, which is either marketed by the farmer or sold to hucksters. Tomatoes, cabbage, beets, rhubarb, turnips, onions, and

squash are produced, the first three predominating. Among the small fruits the strawberry is the most profitable.

The acreage of potatoes has nearly doubled in ten years; fair yields are reported and very profitable prices obtained. There is an immense loss each year from blight and rot—a loss that could be lessened, if not prevented, by spraying the vines with Bordeaux mixture.

Clover is an important crop both for hay and seed, especially in Morrisons Cove. Timothy hay is a money crop and seldom brings less than \$15 a ton. In the spring of 1907 the price reached \$24 a ton.

The development of market gardening has called attention to the adaptation of soils to crops. This is especially noticeable in the market gardening districts near Johnstown and Hollidaysburg. The new orchards are being set out with a view to good location, a well-drained soil, preferably originating from shale rock, having a southern or southwestern exposure, being selected. Much fruit is seen on the eastern slopes of Lock and Dunning mountains.

Crop rotation is practiced by some farmers, but is confined largely to the general farm crops. Truck farmers do not practice systematic crop rotation. The system usually employed is corn, wheat, oats, and timothy. Frequently corn will be planted on the same land for two successive years, but it is not considered best to keep an intertillage crop on the land for more than one year, because of danger from washing and leaching, except in the limestone valleys, where the practice is much safer. Wheat and oats are usually manured and fertilized. Timothy is left on the same land as long as a remunerative crop is obtained, ordinarily from two to five years. In Morrisons Cove clover has a place in the rotation along with timothy. No leguminous catch crops are used, so far as learned, although these offer an excellent opportunity to increase the humus in the soil. When unseasonable conditions prevent a stand of corn, buckwheat is usually planted to take its place.

The price paid for labor ranges from \$20 to \$25 a month with board and lodging; during harvesting and haying \$1 to \$2 a day. One dollar a day is a common daily wage. Italians, Poles, and Hungarians furnish most of the farm labor. On account of the lack of steady labor many farm hands work in the forests during the winter. On dairy farms help is more readily obtainable, as steady employment is assured. Farm values are increasing, and near Johnstown some of the truck land has trebled in value in the last ten years. The increase in the price of farm products has naturally enhanced the value of all farm lands. The price of the timbered area varies according to the kind and condition of the timber growth, the altitude, nearness to markets, and the improvements.

The average size of farms in Cambria County is 95.7 acres, 118 in Blair, and 132 in Bedford County. About three-fourths of the

farms are operated by owners. The tendency is toward a decrease in the size of farms.

According to the United States census reports for a long period of years, the acreage of buckwheat has increased, that of wheat has decreased, owing to western competition, and that of corn is less in Cambria County, but slightly more in Blair County. Rye, never an important crop, has decreased, and the number of sheep kept is steadily diminishing, owing to the damage done by dogs. The acreage of oats has been enlarged, but the greatest increase has been in vegetables and potatoes. Attention is now being particularly given to the growing of hay, vegetables, and potatoes, and to the development of the dairy herds.

In order that the soils of this area may give maximum yields, the supply of humus must be carefully kept up. The natural organic content in newly cleared land is probably sufficient, but after a few plowings and subsequent exposure this supply is largely exhausted and the decrease undoubtedly has a direct bearing upon the decrease of crop yields. This is particularly noticeable in the sandstone and shale soils and only less so in the limestone soils, because the supply has not been allowed to become so much diminished. Where sufficient manure can not be obtained to maintain the humus content, green manuring, particularly with leguminous crops, can be employed instead. Near the larger cities manure from livery stables usually can be obtained for the asking, and sometimes farmers are paid for hauling it away. This permits large applications of the best fertilizer or humus material obtainable, but there is some risk of introducing weeds. Lime is almost universally applied to these soils. It can be obtained from several companies in the area, although many farmers who own limestone deposits burn their own lime. Results obtained at the experiment station, however, would indicate that it is better to apply the powdered rock in all cases, rather than to burn the stone. On a number of the sandstone soils an application of lime is effective for two or three years only, on account of the rapid leaching permitted by their open structure. The ground or powdered rock would not dissolve so rapidly, and hence would be more effective in keeping the soil sweet for a longer period. On the heavier limestone clays it is a common practice to apply lime in order to improve the physical condition of the soil by breaking up the close structure and lessening the tendency of the soil to pack.

Commercial fertilizers are commonly used throughout the area, although not in great quantities. Those high in potash are most frequently bought, and apparently give the best results. The fertilizer requirements of a soil can best be determined by test plots. Such plots can be made and the tests conducted by the farmer himself, and the results observed will be of the highest value, because they will

apply to the soils and conditions on his own farm. Fertilizers are usually applied to wheat, buckwheat, and oats. If home mixing of fertilizers were practiced a considerable saving could be effected, and probably better results could be obtained.

The yield of corn could be increased if careful corn breeding were begun and a definite type of ear and kernel selected. Care should, of course, be taken to select and save the most perfect ears for seed. Certain forage crops—for example, millet and cowpeas—have proved valuable under similar conditions elsewhere. Rape has proved a valuable summer pasture crop for hogs and sheep. Carrots, turnips, mangels, and beets, as winter feed for horses and cattle, are recommended.

A few farmers have tried alfalfa on a limited scale with fair success. It is very probable that with a thorough knowledge of its culture, and of its soil and fertilizer requirements it would be a valuable crop for forage and for improving the soil. It would probably do well on deep, well-drained productive soils that will grow red clover.

On the limestone and Dekalb soils tobacco is not grown, although on the same types under similar climatic conditions it is grown very successfully in other parts of the State.

In certain sections some of the land has been sold to timber and coal companies, who are developing these resources. This unfortunately has led to abandonment of many of the farms. Some of the land in the mountains, on account of altitude and character, is suited only to forestry, and in these places farming should not be attempted. The area has always been the scene of extensive lumbering, and at the present time there is great demand for wood pulp, cooperage material, and construction timber. Locust and chestnut grow very well and are very valuable for making posts, mine props, ties, and poles. Many farmers have a small lot of locust, and this growth is considered by some as a very valuable, if not the most valuable, timber on the farm. Much of the forest land can be used for pasturing stock, and the returns from the farms in this way be increased.

SOILS.

There are so many variations in the soils of the Johnstown area that a study of their formation and classification becomes at once interesting. Some of the soils have been formed by the weathering of the rocks in place, and are therefore residual; some represent the same material reworked by water, and are therefore alluvial; and others are colluvial, or made up of material which originally occupied the highlands, but which gradually has been washed down and accumulated at the foot of the slopes.

The residual soils cover practically all of the upland, and therefore have the greatest extent. As these soils are derived entirely from the underlying rock, some knowledge of the many different geological formations which occur in the area will assist in understanding the consequent soil variations. The rocks of the area are all sedimentary, and were laid down in the Paleozoic era. There were five periods of sedimentation. Named in order, beginning with the latest, these are the Pennsylvanian (Upper Carboniferous), in which the rocks west of the Allegheny Mountains were formed; the Mississippian (Lower Carboniferous), represented by the rocks of the Allegheny Mountains; the Devonian, comprising the rocks which form the eastern foothills and the Juniata Valley; the Silurian, including the mountainous ridges in the eastern half of the area, and the Ordovician, to which the rocks of Morrisons Cove belong.

These rocks are mainly sandstones, shales, and limestones. The sandstone and shale occur in the Appalachian Mountains and Allegheny Plateau, which constitute a distinct soil province.

Variation in color is one of the peculiar characteristics of the rock formations of this province. Most of them have shades ranging from gray to brown, and these give rise to gray and yellow soil. The other formations have a peculiar red color, which is usually intensified in the overlying soil. Both the yellow and the red soils vary widely in texture, which, too, depends upon the material forming the underlying rock. The shales are composed largely of fine material, while the grains in the sandstone may be fine, medium, coarse, or mixed. As a consequence, when the rocks disintegrate through the various agencies of weathering the soil thus formed is composed of the same sized particles as make up the parent rock. The size of its particles and their proportion determine the texture of a soil, and the relation of a soil to soils of similar nature, except in the one question of textures, is the basis of grouping soils in series. We have, then, soil series which are characteristically yellow, and others which are red. The yellow types, when thus grouped, form the Dekalb series. The red soils belong to the Upshur series, which is represented in the area by only three types—Upshur loam, Upshur stony loam, and Upshur stony sandy loam.

The limestone rocks are so radically different from the sandstone and shales in chemical and physical composition and manner of weathering that they constitute a separate soil province—Limestone Valleys province—and form an entirely different group of soils, known as the Hagerstown series. Morrisons Cove Valley, passing across the area in the vicinity of Hollidaysburg, represents this province in the Johnstown area.

Limestone weathers through chemical agencies, the soluble part of the rock being dissolved away and the relatively insoluble residue

forming the soil. Consequently, upon the relative purity of the rock and the character of the residue depends the type of resulting Hagerstown soil. Chert or flint occurring as strata embedded in the massive rock is the most common impurity in limestone. The pure rock yields a reddish soil, with a high clay content and no chert, which is classified as Hagerstown clay loam. The moderately pure limestone leaves a residue of small chert fragments and fine material of lighter texture and color, and this is the Hagerstown silt loam. The soil derived from a very impure rock contains many large chert fragments and is accordingly called Hagerstown stony loam. In places where considerable sand, even though it is derived from a sandstone, has been incorporated with limestone material, the resulting soil is included in the Hagerstown series as the Hagerstown sandy loam.

The alluvial soils are found in stream bottoms, which constitute the third main soil division of this area. All the streams have a decided fall and swift currents. As a result they are deepening, rather than widening, their stream beds, and a very large part of the soil particles which are washed from the uplands into the streams is carried by the water to lower levels outside the area. However, in times of high water strips along some of the larger streams have been overflowed, and narrow bottom lands have been formed by the accumulation of particles too large to be borne away by the current. As might be foreseen, this process results in an assorting of the soil particles according to size, the coarser particles being deposited near the streams, where the current in time of overflow is swiftest, and the finer particles being carried farther from the stream and deposited in slowly moving water. Thus we have a fine sandy loam where the current is the swiftest and a loam where the water is more sluggish. Most of this material has been washed from areas of Dekalb soils and has a distinctly yellowish brown color—a distinguishing characteristic of the Huntington series; consequently we have in the Johnstown area Huntington loam and Huntington fine sandy loam.

Along certain of the streams draining the Upshur stony loam, the red sand grains have accumulated in the bottoms and constitute a sandy loam, but as there is no group of soils with similar characteristics, this material has been classified with Meadow. Other areas occur in the bottoms, which are wet and have other properties foreign to any of the soil series, and these were also mapped as Meadow.

Colluvial material consists of soil particles which have been washed down hill slopes by the agency of water aided by gravity, and which have accumulated at the base of the slopes. While some of this material may be included with the alluvial soils, and although small spots of it occur in the uplands, where it is more extensively developed, it has been called the Lickdale clay loam. In spite of the fact that this

soil is composed of soil particles which at one time belonged to the Dekalb soils and retains many of the characteristics of those soils, it is not included among them, because it differs so radically from them in the manner of its formation.

There are other soils, such as Frankstown stony loam, Morrison sand, Morrison fine sandy loam, and Morrison sandy loam, which have characteristics so foreign to any series that they are given local names. The names Rough stony land and Steep broken land are sufficiently definite and need no explanation.

The following table gives the name and actual and relative extent of each of the soil types:

Areas of different soils.

Soil.	Acres.	Percent.	Soil.	Acres.	Percent.
Dekalb stony loam	144,512	31.7	Huntington fine sandy loam.	4,992	1.1
Rough stony land	63,424	13.9	Chemung stony loam.....	3,328	.7
Dekalb silt loam.....	46,464	10.1	Dekalb clay.....	3,072	.7
Upshur stony loam.....	39,680	8.7	Morrison sandy loam.....	2,560	.6
Dekalb shale loam	35,200	7.7	Upshur stony sandy loam....	2,388	.5
Hagerstown silt loam.....	34,432	7.5	Frankstown stony loam.....	2,048	.4
Dekalb stony sandy loam.....	18,688	4.1	Hagerstown sandy loam.....	1,792	.4
Hagerstown stony loam.....	11,648	2.6	Steep broken land.....	1,792	.4
Meadow	9,792	2.1	Morrison fine sandy loam....	1,600	.3
Dekalb loam.....	9,472	2.1	Upshur loam.....	1,586	.3
Lickdale clay loam.....	7,040	1.5	Morrison sand.....	576	.1
Hagerstown clay loam.....	6,144	1.4			
Huntington loam.....	5,056	1.1	Total.....	457,216	.....

MORRISON SAND.

The Morrison sand to a depth of 6 inches is a mixture of white sand and organic matter, giving a gray, loose, and incoherent sandy soil. The subsoil to 36 inches is a yellow loamy sand or sand which as it is brought up by the auger is loose and incoherent, but which, when exposed to air and sun, dries into small aggregates easily crushed with the fingers. Some small sandstone fragments are found on the surface, but not in sufficient quantity to interfere with tillage.

This soil is found in small spots in the barrens in Morrisons Cove. These occupy usually the tops of knolls and ridges at elevations of about 1,600 feet, or about 200 feet above the general level of the limestone valley. Owing to the loose texture of the soil and its topographic position it is very thoroughly drained, and if cultivated the crops would probably suffer more or less from drought.

The Morrison sand has been derived by weathering from a sandstone stratum in the limestone, the particles having accumulated on high level tracts where washing is at the minimum.

So far as known none of this type is under cultivation, but is covered by a dense second growth of chestnut, with some jack pine and

scrub oak. Underbrush consisting mostly of blackberry bushes is very common. Under the present forest conditions with the covering of vegetable mold the sand seems to retain moisture well, and this soil may well be left in forest, although the general character of the growth can be greatly improved.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Morrison sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17172.....	Soil	0.4	6.5	15.0	56.3	4.2	12.1	5.9
17173.....	Subsoil.....	.4	7.1	17.2	50.9	3.6	12.7	7.6

MORRISON FINE SANDY LOAM.

The surface soil of the Morrison fine sandy loam, which is seldom over 6 inches in depth, consists of a gray very sandy fine sandy loam or fine sand, moderately loose and incoherent in structure. The subsoil from 6 to 36 inches in depth is a light-yellow, very loose incoherent fine sand or light fine sandy loam containing considerable sand of all grades. This material becomes whiter and finer with depth, until at 36 inches it is a white fine to very fine sandy loam which contains considerable silt. Small rounded quartz gravel occurs on the surface and throughout the soil and subsoil, and occasional small spots are found which carry sufficient of this coarser material to warrant classification as a gravelly soil. There are also some small sandstone and conglomerate fragments scattered over the surface, but seldom in such quantities that removal is necessary.

The Morrison fine sandy loam occurs in a very narrow band and is found associated with the Frankstown stony loam, being the second soil encountered in ascending the slopes of the limestone ridges in the vicinity of Frankstown from the east. Occurring on the hillsides and having a gently sloping to very steep topography, the drainage is both rapid and complete, while the open, incoherent structure of the soil renders cultivation easy.

The Morrison fine sandy loam has been formed by the disintegration of the Oriskany sandstone, which is exposed in a narrow band between the water lime rocks of the Lower Helderburg and the shales of the Hamilton formation. The type is about half in oak and chestnut timber and the other half is devoted to general farming or garden plots. As cultivated fields on these slopes usually contain some Dekalb shale loam, some Morrison fine sandy loam, and Frankstown stony loam, and as little effort is made to specialize crops on these

soils, it is difficult to estimate the crop yields accurately, but the Morrison fine sandy loam is not considered a good general farming soil because of its inability to hold fertilizers and lime. However, if brought to a high state of productiveness with manure it would make an excellent truck soil. It is usually of sufficient extent on the farms where it occurs to produce a great deal of truck, for which there is a ready market.

The soil is not adapted to general farming, and yields of corn, wheat, and oats are comparatively low. Lime, manure, and commercial fertilizers are applied at the rate of about 200 pounds each to the acre.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Morrison fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
17086.....	Soil	3.1	6.7	8.9	39.6	13.9	16.9	10.8
17087.....	Subsoil.....	4.2	7.6	5.8	29.7	28.4	20.9	8.2

MORRISON SANDY LOAM.

The Morrison sandy loam is a gray to yellow sandy loam about 8 inches deep, underlain by a yellow subsoil, which becomes heavier with depth until at 36 inches it is a heavy loam or clay loam. From 5 to 20 per cent of the soil mass is made up of sandstone fragments. These, however, are rarely an impediment to cultivation. The soil is not uniform, as small areas occur which vary to lighter or heavier textures.

This soil is not extensive, but occurs in several isolated areas in the western part of Morrisons Cove. It occupies slopes and ridges in the "barrens," which have an elevation of 1,500 feet, and consequently drainage is excellent. Droughts do not have the damaging effect upon crops that might naturally be expected on so light a soil, though, nevertheless, a good mulch is necessary to maintain the soil moisture.

The Morrison sandy loam is derived from the same sandstone band in the limestone that gives rise to the Morrison sand, but the accumulation of sand grains has not been so great.

Little of this soil is in cultivation, and it is not considered nearly so good as the Hagerstown sandy loam, with which it is easily confused. Chestnut, pine, and oak trees, with considerable underbrush, constitute the principal vegetation. It is doubtful if this soil is adapted to general farm crops, but for trucking it should be one of

the best upland soils of the area. Fruit would doubtless be successful, and some few orchards of peaches, pears, and apples were seen. Pears appeared particularly thrifty. No accurate crop yields could be determined from the small areas in cultivation.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Morrison sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17880.....	Soil	2.3	12.6	16.0	84.6	9.0	18.8	7.0
17881.....	Subsoil.....	.3	9.7	15.9	38.4	9.8	17.0	13.5

DEKALB STONY SANDY LOAM.

The Dekalb stony sandy loam is a loose-structured, dark-gray or gray sandy loam, 7 or 8 inches in depth, underlain by dark-yellow slightly sticky sandy loam, which becomes little, if any, heavier to a depth of 36 inches. The line of demarcation between soil and subsoil is quite pronounced. The sand grains are mostly medium or coarse, although in some places the percentages of the finer grades may be appreciable. Small quartz gravel is found throughout the soil in some localities. Considerable organic matter is usually mixed with the top soil. At least 25 per cent of the surface is occupied by fragments of medium to coarse-grained sandstone or conglomerate, the removal of which is necessary before cultivation can be successful.

There are several isolated areas of this soil, the principal ones being in the vicinity of Ebensburg, Cresson, New Germany, and along the crest of the Allegheny Mountains and in Morrisons Cove.

The areas west of the Alleghenies have been formed by the weathering of the Saltsburg sandstone of the Conemaugh formation, those in the Alleghenies by the weathering of the Pocono sandstone, and those in Morrisons Cove from a sandstone stratum in the limestone the identification of which is uncertain. In all cases the incomplete disintegration has given rise to the stony character of the soil.

This soil is largely covered by timber growth, chiefly chestnut, although some maple, pine, and hemlock are seen. Little of the land is under cultivation, that cultivated being mostly by small farmers, whose principal livelihood is derived from the timber rather than the soil. The low yields of buckwheat, hay, and vegetables do not warrant cultivation further than to supply home demands.

Fertilizers and lime are applied in some localities, but the texture of the soil allows rapid leaching. Barnyard manure seems to have the most enduring effect upon this soil.

It is so easily handled that in places convenient to markets where the altitude allows sufficient length of season the trucking industry could be more fully developed. In Morrisons Cove it is probable that orchards of apples, plums, pears, and other fruits would be profitable. If proper varieties of chestnuts could be selected the groves would prove profitable.

The character of the original timber and the difficulties connected with the production of other crops are evidences that this soil should be left in forest, which undoubtedly in time to come will prove remunerative.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Dekalb stony sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Veryfine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17056, 17872.....	Soil	2.4	16.1	21.9	16.8	5.0	25.1	12.1
17057, 17873.....	Subsoil.....	3.1	17.8	18.8	17.1	4.6	25.0	13.1

DEKALB LOAM.

The surface soil of the Dekalb loam varies from a light to dark gray or brownish fine-textured loam, 6 to 8 inches in depth, underlain by a yellow loam which, owing to a slightly increased clay content, becomes somewhat heavier with depth. Strewn over the surface and distributed throughout the soil and subsoil, the quantity usually increasing with depth, is found from 5 to 20 per cent of small sandstone fragments, which, however, do not materially hinder cultivation. Freshly disintegrated and broken sandstone rock often comes within 24 inches of the surface.

The Dekalb loam occurs in isolated bodies, the greatest number being in the vicinity of Geistown and Ebensburg and Morrisons Cove. The area southwest of Ebensburg is distinctly more sandy than the Geistown areas. A phase of the loam was seen near Noel station, and other small bodies which are micaceous were found. In these spots, although the surface is practically typical, the subsoil becomes lighter with depth.

Situated on high, gently rolling uplands, the drainage of the Dekalb loam is usually sufficient, but near the heads of streams artificial drainage could well be employed.

The Dekalb loam has been formed by the weathering of fine-grained sandstone and sandy shales of the Conemaugh formation and, in Morrisons Cove, by the weathering of sandstone, although it is possible that limestone has here had some part in the formation of the soil.

Chestnut and oak were the original tree growth, but the forests have largely been cleared off and the land put under cultivation. This is one of the best soils of the area and is devoted to general farming. In the areas nearest Johnstown potatoes and cabbage are important crops and do well. Orchards are numerous and are apparently productive. Commercial fertilizers are used to some extent, but manure and lime are the favorite fertilizers and seem to give the best and most lasting results.

More of this land could be brought under cultivation, especially where markets are available. It would seem that this type is eminently adapted to growing fruit, especially apples and, possibly, peaches.

The organic matter content of the Dekalb loam should be increased, not only by more frequent applications of manure, but also by the growing of leguminous crops, such as clover and cowpeas.

The land varies in price from \$50 to \$200 an acre, depending largely upon its situation in regard to markets.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Dekalb loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17064, 17064, 17124.	Soil	1.5	3.0	2.6	21.6	9.6	44.9	16.3
17065, 17065, 17125.	Subsoil	1.1	3.5	2.5	20.2	9.7	41.8	21.0

DEKALB STONY LOAM.

The soil of the Dekalb stony loam, which has an average depth of 8 inches, is a light yellowish-brown or gray heavy loam or loam containing considerable fine sand. The virgin soil has a rather compact and close structure, but when cultivated the soil particles have a tendency to aggregate, and then it becomes more open, friable, and easily tilled. The subsoil, from 8 to 36 inches, is a yellow loam, becoming somewhat heavier with depth until a distinct clay loam is developed. The aggregated structure prevails in the subsoil also. The distinctive feature of this soil is its high stone content. Sandstone fragments of all sizes, and of all textures, from fine-grained to coarse conglomerate, are found strewn or piled on the surface and disseminated through the soil and subsoil in such quantities that cultivation without their removal from the surface is impossible, and even then often difficult. It is seldom possible to bore into this soil more than a few inches.

The Dekalb stony loam is well distributed over the area, occupying the mountainous areas. It is most extensively developed in the

Johnstown quadrangle, where it occupies the approaches to Laurel Ridge and the severely eroded areas adjoining the Conemaugh River and its branches and Blacklick Creek. In these sections is found a phase of the type in which the subsoil may be a sandy clay instead of a clay loam. The second largest area of the soil occurs at the eastern boundary of the Conemaugh formation, which extends from the northeast to the southwest corner of the Ebensburg quadrangle. Other prominent areas are found on the approach to Brush Mountain, northeast of Hollidaysburg, and the approaches to the mountainous ridges which form the boundary of Morrisons Cove. The Brush Mountain area and the one on the western side of the Loop Mountain ridge have a subsoil which in places has a distinct reddish tinge, although the texture is nearly typical.

In general, the Dekalb stony loam is formed by the disintegration of sandstone and shale rock, but the character of the rock may vary in the different areas. The western areas are formed from the Conemaugh series of rocks, which consist of alternate strata of sandstone and shale. The shale weathers more rapidly than the sandstone, and in the worst eroded regions of these formations the shale has not only disintegrated, but has eroded away, leaving the sandstone fragments in the soil. The Brush Mountain area and the one on the western approach of Loop Mountain ridge have been formed partly from disintegration of the Clinton shales, but largely by the accumulation of fragments of Medina and Oneida sandstones which have rolled down from the higher mountain slopes. The areas on each side of the cove were formed in a similar manner by the accumulation of Medina and Oneida sandstone fragments over the Hudson River shales. The Pocono formation has also given rise to some of the type west of the Allegheny front.

From the character of the topography it is plainly evident that natural drainage is well established, and while erosion is very active, where cultivated the land is seldom washed or gullied.

The natural tree growth is largely chestnut, but hemlock, oak, and beech are common. Most of the timber has been cut and the land left in a very bad condition, although a few areas occur where the underbrush is kept down and the land is used for pasture.

Owing to the very rough topography and the excess of stones only a small proportion of the type, usually adjacent to other types, is under cultivation. It is, in such cases, used for garden or general farming crops. The main source of revenue from the Dekalb stony loam is derived from the sale of timber or mining rights. The stones are so numerous and the underbrush so thick and dense that the cost of clearing is not warranted where the land is to be used for extensive general agriculture. The great demand for truck and dairy products has brought about the improvement of the greater part of

this soil now cultivated, and this will continue, particularly where the land lies accessible to markets and is less stony. The value of this soil depends, therefore, more upon the topography and the quantity of stones than upon any particular crop adaptation. Nearly all of the crops of the area are produced in the cultivated areas, but yields are relatively poor.

Permanent pasture on which cattle and sheep can be raised is one of the best uses to which the Dekalb stony loam can be put. With proper care orchards might be remunerative, but this industry should be entered upon with considerable caution. A good variety of chestnut grafted upon native stock would probably pay, but so far as learned this has not been tried. On the other hand, the soil is naturally adapted to forestry, and if planting and management is conducted along scientific lines most of it can be put to profitable use with little difficulty.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Dekalb stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17050.....	Soil	0.3	2.8	4.3	21.5	6.1	48.4	15.6
17051.....	Subsoil.....	2.0	5.4	7.1	14.6	7.1	40.5	23.0

DEKALB SILT LOAM.

The soil of the Dekalb silt loam, to a depth of 6 to 8 inches, is a dark grayish-brown silt loam of rather open structure and easy tillage. It is underlain by a lighter colored loam or clay loam which becomes somewhat heavier with depth and is usually mottled with yellow or drab. A large quantity of small shale fragments occurs on the surface and throughout the soil and subsoil, the quantity usually increasing with depth. Some sandstone fragments are also found, but these are usually well scattered and small, although on the tops of some of the knolls and ridges there may be a sufficient number to hinder cultivation. Freshly disintegrated or solid shale rock can usually be found at 24 to 30 inches, and this imparts a greasy feel to the subsoil.

This soil occupies rolling to hilly topography and is characterized by knobs and steep-sided ravines; consequently the land suffers more or less from erosion and the soil profile is not very uniform. On the tops of knolls and ridges the material is removed almost as fast as broken down, leaving a very shallow covering, which is more a mass of shale fragments than a true soil. The accumulation of silt and clay from above has formed a heavier, deeper soil on some of the

slopes and narrow flats, but these areas, as a rule, are so small that separation was impracticable. Except in some places where the soil is heavier drainage is usually good, and although the soil has a very open structure it is claimed that it withstands drought well.

The Dekalb silt loam is found on the two ridges running north of Johnstown, and on the general slope from Ebensburg to Cresson and Wilmore, extending southwest to the vicinity and north of Elton. Smaller areas occur throughout the Carboniferous formations.

Variation in this soil is due in part to the fact that it is formed through weathering from the Conemaugh shales, which in themselves differ greatly. These have not weathered to a uniform depth, and the soil may be several feet deep in one place and in another, only a few feet distant, comparatively shallow.

Being the most important type of soil derived from the Conemaugh formation, except for the steeper slopes along streams, in forests of hemlock, oak, beech, and chestnut, it is nearly all under cultivation. Although a great many farms are neglected and have depreciated because of poor cultural methods, where well cared for produces fair crops. Oats yield about 40 bushels and wheat about 20 bushels to the acre. It is not a corn soil, as corn, owing to the short season, is not a sure crop, but in good years yields about 75 bushels in the ear. Constant fertilization and manuring is absolutely essential to the production of good crops. Lime and manure do best if applied immediately after the hay is removed from the meadow. This promotes a strong root growth and when plowed under increases the quantity of humus, which is the most difficult of soil ingredients to maintain. Little grain is sold, although some wheat and rye, baled straw, and hay are disposed of. The income is derived principally from stock and stock products. Some farmers feed young stock during the winter and sell them the following summer. Land of this soil type is worth, on an average, about \$35 an acre, depending upon improvement and market facilities.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Dekalb silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17052.....	Soil	3.9	3.9	1.3	3.6	8.2	60.1	18.9
17063.....	Subsoil.....	5.8	6.5	2.3	4.5	8.7	49.8	22.1

DEKALB SHALE LOAM.

The Dekalb shale loam to a depth of 6 to 8 inches consists of a gray, yellowish, or brownish-gray silty loam, underlain by a somewhat heavier and lighter colored subsoil which extends to depths rarely exceeding and often less than 24 inches. From 10 to 60 per cent of the surface is occupied by shale and sandstone fragments varying in size from mere chips to large flat pieces one-half inch to 1 inch in thickness and 1 to 2 feet in circumference. The shale nearly always predominates and the content increases with depth until the subsoil gives way to the bed rock. The presence of this shale has a great influence upon the physical condition of the soil, giving it the character of a light-textured soil, and consequently it can be worked at almost any time.

Three phases of the Dekalb shale loam are found in the area. The largest body occurs as a band from 1 to 3 miles wide, running in a general north-and-south direction between Altoona and Queen. The next largest area is situated just east of Frankstown, and the third occurs as a broken band at the foot of the high terrace which surmounts Morrisons Cove. The latter area carries more than the usual quantity of sandstone and less of the large shale fragments, but the usual large quantity of shale chips. A stony phase occurs along the western border of the first area adjacent to the Chemung stony loam. Here the number of large shale and sandstone fragments is so great that many must be removed to permit satisfactory tillage of the land.

The main part of the type is characterized by a succession of rounded knobs, with elevations of about 1,800 feet, from which radiate in all directions except west narrow ridges that slope rapidly to the flood plains of the many streams, which are from 900 to 1,100 feet in elevation. Small rounded knobs peculiar to shale formations are also found at intervals on the ridges. Steep-sided ravines are very numerous in this type. Owing to the rough topography the drainage is thorough or even excessive, though the evidence of severe washing or gullyng is rarely observed. The open structure caused by the shale fragments permits a large percentage of the rainfall to be absorbed, and this reappears in spots as seepage, making the soil in these places soggy, cold, and wet.

The greater part of the Dekalb shale loam has been formed by the disintegration of the slates and shales making up the Chemung, Nunda, Genessee, Hamilton, Marcellus, and Upper Helderburg formations of the Devonian age. The small areas in the vicinity of Hollidaysburg have been formed from the Clinton shales of Silurian age, and the areas surrounding Morrisons Cove have been derived from the Hudson River shales and Utica shales of Siluro-Cambrian age. Most of these formations are made up of shales of various colors with sandstone lentils. The shales are comparatively soft and

have weathered quite rapidly, while the sandstone, being harder, has accumulated on the surface. Hence the Chemung formation, which contains a great deal of sandstone, has given the stony phase of this type, or even in places the Dekalb stony loam. The Clinton and Hudson River shales have weathered more completely than the others, and consequently fewer of the larger shale fragments occur in these formations. From some of the higher elevations the soil particles have been removed by washing almost as fast as made, leaving only a mass of shale particles, while the accumulation of these on the lower slopes has given a deeper soil.

With the exception of its stony phase this type is largely under cultivation. The general farm crops are grown on it, although it is not considered a strong corn soil, the average yield per acre ranging from 30 to 50 bushels in the ear. Wheat averages 10 to 12 bushels, oats 30 to 35 bushels of good quality, but buckwheat is not generally grown on this soil.

The practice of general farming is rapidly giving way to trucking, potatoes, tomatoes, and cabbage being leading crops. The good roads make it possible to market these products, so that the farmer plants enough grain and cuts enough hay for his own use and depends largely upon truck as the money crop. Dairying is not so general as it should be, considering existing market conditions and the demand for manure created by the trucking industry.

It is said that lime effects a marked increase in crop yields on this soil, and commercial fertilizers are also used to some extent.

Land of this soil type is held at \$30 to \$100 an acre, depending upon the location and convenience to markets.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Dekalb shale loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17182.	Soil	1.8	5.7	1.5	2.0	1.0	67.5	20.6
17183.	Subsoil	2.0	6.8	1.7	2.5	1.7	68.2	21.6

UPSHUR LOAM.

The Upshur loam consists of a brownish-red heavy loam, 7 inches in depth, which has a slight tendency to bake, but which is not difficult to bring into a good condition of tilth. The subsoil to a depth of 36 inches is a deep Indian-red clay loam which becomes heavier with depth and is in many places mottled with yellow in the lower depths. The soil carries about 20 per cent of sandstone fragments which doubtless come from formations higher up the slopes.

The soil occurs in a rather narrow, broken strip about 2 miles west of the Allegheny Front. It occupies gentle to rather steep slopes, although where the topography is very rough it has been mapped as Rough stony land. It is well drained, but does not suffer from drought.

The Upshur loam has been formed by the weathering of the red shale in the Mauch Chunk formation and has been influenced by the accumulation of fragments of sandstone from the Pocono formation.

Very little of the soil is under cultivation and accurate estimates of yields are hard to secure, but it is considered a good type, and in places quite productive. Small farms could be cleared on this type, but they would be isolated and very inconvenient to markets.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of the Upshur loam:

Mechanical analyses of Upshur loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17066.....	Soil.....	0.7	5.0	3.7	7.9	3.6	52.1	26.5
17067.....	Subsoil....	.7	5.7	4.9	11.0	5.7	43.9	23.0

UPSHUR STONY LOAM.

The soil of the Upshur stony loam, which has an average depth of 6 to 8 inches, consists of a fine-textured, reddish-brown loam, containing an appreciable quantity of fine sand and a marked proportion of silt. It has a rather open structure and is easily tilled. The subsoil becomes somewhat heavier with depth and consists of a rather compact dark Indian-red clay loam, which overlies sandstone rock at depths varying from a few inches to several feet. Strewn over the surface and disseminated through the soil and subsoil are from 10 to 35 per cent of red, flat, sandstone fragments, which vary in size from mere pebbles to pieces 2 feet in circumference. Many soft red shale fragments also occur in the soil and subsoil.

The Upshur stony loam occupies two distinct areas. The largest and most important is situated in the central part and the other surrounds Morrisons Cove on the side of the mountain. The former body lies in a strip at the foot of the Allegheny Front and varies in width from $1\frac{1}{2}$ miles at the northern boundary to about 6 miles in the center and about $4\frac{1}{2}$ miles at the south boundary.

In topography this area is steep and broken. It is made up of very steep slopes and hogback ridges and knobs. The elevations range from about 1,500 to 2,400 feet above sea level, and consequently drainage is rapid though apparently not excessive, and except in a

few places where the rock comes close to the surface the soil seems to stand drought well.

This body of the Upshur stony loam has been formed by the disintegration of soft red shales and fine-grained sandstones, alternate layers of which make up the Catskill formation. The sandstone weathers more slowly than the shale, and its accumulation on the surface and in the soil gives the type its stony character.

The greater part of the area is in chestnut and oak, generally of excellent quality. The farms are usually small and are located along the streams where water can be easily obtained. General farming is carried on, but crops must be cared for and harvested by hand. Sleds are in common use on these hillsides where wagons are impracticable, as the type has the distinction of having steeper slopes in cultivation than any other in the area. This is probably due to the fact that it is considered a very strong soil. Wheat gives from 10 to 20 bushels, oats 20 to 35 bushels, corn 40 to 60 bushels, and buckwheat from 15 to 20 bushels per acre. Only enough grain is produced to supply food for the family and for feeding farm animals. Little stock is kept, so that little of the cleared land is given up to meadow or pasture. On areas favorably situated the growing of truck crops is becoming more general. The sale of wood forms an important part of the farmer's income.

At present very little of this area is accessible, or at least convenient to market, so that products when marketed must be in small bulk, on account of difficulties of transportation. Stock should be kept in greater numbers, as by using the manure the humus content of the soil could be increased. Again, the land would not have to be so thoroughly cleared for stock raising as for the cultivated crops. Although little attention is paid to fruit growing here, from the success attending such efforts elsewhere on similar soil it seems highly probable that certain varieties of apples and grapes, if well cared for, would prove highly profitable. On the roughest part forestry is now and will probably always be the predominating industry.

The value of the land depends largely upon the standing timber, and varies from \$10 to \$100 an acre.

The second area referred to is on the upper slopes of the mountain chains which border Morrisons Cove. It is found usually between elevations of 1,600 and 2,000 feet and has consequently a steep topography and thorough drainage. Immediately above the Upshur stony sandy loam the surface of this body is a gentle slope and well suited to general farming, although the soil is inclined to be droughty. Practically none of this area is under cultivation, but is covered with an excellent growth of chestnut. The inaccessibility of this area and the lack of water will probably retard cultivation in this section.

The soil in this area has a somewhat higher content of sand, due no doubt to the fact that it is derived principally from the red Medina sandstone and less from red shale than in the other area mentioned. Generally a greater quantity of stone, in larger fragments, is found in this soil than in the area first described.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Upshur stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17126.....	Soil	0.9	3.2	0.9	8.8	14.0	55.0	16.9
17127.....	Subsoil	.6	4.8	1.5	6.5	11.9	55.8	18.5

UPSHUR STONY SANDY LOAM.

The soil of the Upshur stony sandy loam has a depth of about 8 or 10 inches, and consists of a reddish-gray sandy loam. This material becomes sandier and redder with depth, until at 36 inches a rather loose-structured Indian-red sandy loam is found. Occasional spots of loose, incoherent sand occur throughout the type. Except in local spots this soil is not as stony as either the Upshur stony loam or the Dekalb stony loam, but the sandstone fragments and boulders are sufficient to make clearing and cultivation difficult.

Of rather small extent, the type is confined to the high terraces that occur at intervals along the sides of the mountains bordering Morrisons Cove. These terraces lie about 400 feet above the valley, at elevations of 1,700 to 1,900 feet, or about half way up the mountain sides. They are not level, but have gentle to rather steep slopes, which, with the character of the soil, insure complete drainage.

In origin the type may be traced to the red Medina and gray Oneida sandstones, from which it has been derived through the various processes of weathering. To the sandstone, which is very hard and resistant, is attributed the formation of the terraces. The land is left exclusively to forest. A fair quality of chestnut and a few oaks represent the tree growth. It is probable that forestry is the best use to which it can be put, though proper methods should be used to improve the trees. Clearing the land of forest and stones for tillage would be very expensive, and it is likely that the crops would suffer from drought. Water for domestic use would also be very difficult to obtain.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of the Upshur stony sandy loam:

Mechanical analyses of Upshur stony sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17170.....	Soil	0.7	4.8	14.4	36.9	2.4	33.1	8.2
17171.....	Subsoil.....	.0	3.9	19.6	41.3	3.2	24.0	8.3

HAGERSTOWN SANDY LOAM.

The Hagerstown sandy loam consists of 10 inches of a reddish-yellow sandy loam, underlain by a subsoil which becomes heavier with depth and grades into a sticky reddish-yellow loam or clay loam at 34 inches. Typically some small sandstone and flint fragments occur on the surface, and local areas where the quantity is detrimental to agriculture have been indicated on the map by symbol. While this soil is fairly uniform, the depth of the sandy loam surface soil may vary somewhat in the different, isolated areas where it is found. It usually occurs adjacent to the so-called "barrens" of Morrisons Cove, and occupies gentle to steep slopes. Drainage is always good and in times of extreme drought the crops suffer for moisture to some extent, though such instances are very rare.

The Hagerstown sandy loam is locally called mixed sandstone and limestone land. The processes of its formation are somewhat doubtful, but it is evident that there has been an accumulation of sand and sandstone over weathered limestone, either from direct disintegration of sandstone or by wash from the sandstone formation which occurs in tiers on the hills above. The latter process seems the more probable.

Most of this type is devoted to general farming, but more or less truck is also grown. It is a very good soil on account of the ease of cultivation. Commercial fertilizers, lime, and manure are applied with good results, the heavy subsoil preventing leaching, which is a very common fault with sandy soils.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Hagerstown sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17168.....	Soil	1.4	10.4	13.4	26.5	3.3	34.3	10.3
17169.....	Subsoil.....	.5	7.6	12.7	26.7	3.1	26.0	22.7

HAGERSTOWN CLAY LOAM.

The Hagerstown clay loam consists of 10 inches of brownish-red heavy silt loam or clay loam, underlain by a heavy red clay loam or clay subsoil of very compact and tenacious structure. At depths varying from 15 to 25 inches there usually occurs a few inches of gray silty material, which when rubbed rapidly turns red and assumes the character of the subsoil. Solid limestone rock immediately underlies this material at depths varying from 18 to 34 inches. Hard blue limestone fragments are found on the surface in varying quantities, but are seldom numerous enough to affect cultivation. Outcrops of the limestone are numerous, but no chert was found in this soil.

Hagerstown clay loam occurs in small isolated areas in Morrisons Cove and on the limestone ridges in the vicinity of Hollidaysburg and Frankstown. It occupies gentle to steep slopes and narrow, flat-topped ridges, and in general has good surface drainage.

Derived from the pure Trenton chazy and calciferous limestone in Morrisons Cove and from the Lower Helderberg near Hollidaysburg, all of which belong to the Cambrio-Silurian age, the soil is found in those places where erosion has been sufficiently active to remove the silty material which is characteristic of the Hagerstown silt loam and leave only the finest material which has accumulated immediately above the rock. Such areas were originally covered with oak forests, but the larger part has been cleared, and this is considered the strongest soil in the area. Owing to its fine texture and close structure, however, great care must be taken to plow it under the proper moisture conditions; if it is dry too great a draft is required to do the work economically, and if too wet good physical condition of the seed bed is impossible, because of the great number of clods formed. Fall plowing is essential, so that the soil may be loosened up by the winter frosts.

Commercial fertilizers are used very sparingly on this type, but lime is often applied, not to correct acidity in the soil, but to flocculate the fine particles, thus making it more open in structure and easier to work. Although the yields on this soil are not much greater than on the Hagerstown silt loam, a good crop is considered assured without regard to season. Corn, wheat, and oats are the favorite crops, but timothy and clover are extensively grown and the disagreeable feature of constantly working the soil thus eliminated. Alfalfa is grown to some extent and appears to do very well.

HAGERSTOWN SILT LOAM.

The Hagerstown silt loam consists of 8 to 10 inches of a brown, grayish, or reddish-brown silty loam or very fine-textured loam, immediately underlain by 15 inches of yellowish heavy silt loam or clay

loam which at 24 to 28 inches grades sharply into a tenacious reddish clay loam or clay, extending to unknown depths. The organic-matter content is comparatively high, and some small chert fragments are nearly always present, and in some cases as much as 20 per cent of the surface may be occupied by them. Usually they do not interfere appreciably with handling the soil, though it is sometimes beneficial to remove some of the larger fragments from cultivated fields.

Except for slight variations in depth and the quantity of chert, there are no well-defined phases of this type, and in general it is remarkably uniform. The structure is such that the soil is much more easily worked than might be expected from the mechanical analysis. Under field conditions it is a light, open soil, loose and friable, and very rarely subject to baking or puddling. In wooded areas, where the incorporated organic matter is less, the soil is a little more yellow in color and has a more mealy texture than in the cultivated fields.

The Hagerstown silt loam is extensively developed in Morrisons Cove in the eastern part of the area and in the vicinity of Hollidaysburg. It occupies by far the greater part of the limestone land in the survey, and Martinsburg is largely dependent on the agricultural products grown upon it. It has a rolling topography, occupying broad-topped ridges and knolls, and along streams the gentle slopes to the lowlands. It has, therefore, good surface drainage, and has been injured only to a very limited extent by washing. The soil retains moisture well and appears to be capable of withstanding any drought likely to occur.

In Morrisons Cove the Trenton and Chazy limestones and calciferous sandstone, a transitional formation, give rise to this soil, and near Hollidaysburg the Lower Helderburg has resulted in important areas of it. It represents the insoluble residue from large masses of limestone, the calcium carbonate having been removed in solution. The soil accumulation is remarkably deep in places, a depth of 90 feet having been noted, but outcrops of limestone occur frequently, especially along ravines, and in such places bodies of Hagerstown clay too small to be shown on a map of the scale used also occur.

This is the most popular soil in the Johnstown area. Its ease of cultivation, inherent fertility, and comparatively smooth topography make it a very desirable soil for general farming. Corn is probably the principal crop and yields on the average from 75 to 100 bushels in the ear. Wheat yields about 25 bushels, oats 40 bushels, and hay about 2 tons to the acre. Dairying is the principal occupation and most of the income is derived from milk, for which the farmers receive a good price in Altoona and Johnstown. Some butter is also made and shipped. Little attention is given to raising beef cattle, and hogs are not kept to any great extent. Silos are common, the

farm buildings are well improved, and the farms have an air of prosperity. Renting farms is a common practice, and the tenants remain upon the same farm usually for long periods. Clover is extensively produced and alfalfa is being experimented with and, so far as known, no complete failures have been experienced, while on the other hand some marked successes have been achieved. Commercial fertilizers in which phosphorus and potassium are the principal elements are claimed to increase crop yields and are applied extensively at the rate of about 200 pounds to the acre. Although this is a limestone soil, the calcareous material has been very completely dissolved and acids detrimental to crop yields have accumulated in the soil. It has therefore been a long established practice for the farmer to burn limestone, which is usually obtainable on his farm, and to apply the resulting lime to the land. Lime can be purchased at the kiln for about 8 to 10 cents a bushel. It was formerly applied in large quantities at infrequent intervals whenever diminishing yields seemed to demand it, but it is becoming more common to apply it at the rate of about 30 bushels an acre every two or three years. With dairying large quantities of manure are being made and applied to the land. Farms of this type of soil are held at \$60 to \$75 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Hagerstown silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17884.....	Soil	0.8	2.0	1.2	2.8	3.4	71.13	18.4
17885.....	Subsoil.....	1.4	3.7	3.9	4.7	6.2	48.1	31.

HAGERSTOWN STONY LOAM.

The fine earth composing the first 8 inches of Hagerstown stony loam is a silty loam, the upper 4 inches of which is gray in color and the second 4 inches yellowish gray. The subsoil, extending from 8 to 36 inches, is a heavy silt loam, becoming heavier and passing from yellow to reddish in color, until at about 24 inches a heavy reddish clay loam is found.

A striking characteristic of this soil is the large number of chert fragments on the surface and disseminated throughout the soil and subsoil. Boring through the subsoil is seldom possible, and cultivation at the surface is very much hindered by the stones. However, in many places they have been removed at great expense and the land brought under cultivation. This type has been confined to

areas which have at least 25 per cent of flint fragments on the surface.

The Hagerstown stony loam is found principally in Morrisons Cove, where it occurs in fairly uniform bodies occupying in a general way the land adjacent to the sandstone ridges of the valley. A few areas are also found on the limestone ridges in the vicinity of Hollidaysburg, but for the most part these areas are too small to be indicated on the map. The soil has good surface drainage.

The Hagerstown stony loam has been formed by the solution and subsequent filtration of a very impure limestone. The impurity consists largely of chert or flint, which, being but slightly soluble, has remained and given the soil its stony character.

Known locally as "flinty land," the Hagerstown stony loam is considered the least productive of the limestone soils. However, when care is taken to rid the surface of stones, fair crops are nearly always secured. Corn will probably average 35 bushels, oats 35 bushels, and wheat 15 bushels to the acre. Liming is extensively practiced on this type. Light applications of commercial fertilizers, of which potassium seems to be the most valued constituent, are also made.

Improved soil of this type is held at \$50 to \$75 an acre, the quantity of chert in the soil influencing the price considerably.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Hagerstown stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17882.....	Soil	8.2	5.7	2.6	5.1	5.4	68.7	13.4
17883.....	Subsoil.....	1.6	5.6	3.3	5.4	5.0	42.3	36.1

HUNTINGTON LOAM.

The Huntington loam consists of about 8 inches of brown fine-textured loam, underlain, to a depth of 36 inches, by a very light brown silt loam or loam. In areas receiving wash from limestone soils a darker brown predominates. The surface soil varies little in texture, although in places the color changes to yellowish. The subsoil, however, varies greatly in both texture and color, and may be lighter in texture than the soil and of a decided shade of yellow. The areas of yellow-colored material, which are scattered throughout the type, are likely to be confused with the Lickdale clay loam. Gravel and rounded stones are quite common in this type, and areas where the agricultural value is affected by them have been indicated by symbol.

The largest bodies of Huntington loam occur in the valley of the Juniata and its tributaries, where they occupy comparatively wide bottoms, though separated from the streams by other types of soil. This land is level or rises gently to the upland, is very seldom overflowed, and is usually sufficiently elevated to give good drainage.

An alluvial deposit, the Huntington loam is composed largely of particles washed from adjacent shale and sandstone formations and redeposited in slowly moving water. It is one of the most valuable soil types in the area, and is more generally used for and better adapted to general farm crops than the Huntington fine sandy loam. However, potatoes, tomatoes, and cabbage do well and are extensively cultivated. It is a desirable soil, both on account of ease of cultivation and because of its natural fertility and adaptation to a wide range of crops. Fertilizers, although not so much used on this soil as upon the soils of the uplands, have lasting beneficial effects. Corn is one of the best crops and yields about 80 bushels in the ear, while the other farm crops yield correspondingly well. Trucking has proved very profitable. Good roads are found throughout the districts covered by this soil, and as the markets are near, the land has a high value.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Huntington loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17134.....	Soil	0.2	1.4	1.1	14.8	15.0	53.0	14.7
17135.....	Subsoil.....	.1	.3	.4	6.4	10.0	58.3	23.9

HUNTINGTON FINE SANDY LOAM.

The soil of the Huntington fine sandy loam, to a depth of 8 or 10 inches, is a brown fine sandy loam, loose in structure and easily worked. The subsoil is a somewhat lighter colored fine sandy loam, becoming more sandy with depth. Occasionally a band of heavy loam occurs in the lower depths.

This soil occupies stream bottoms mainly in the vicinity of Johnstown and along Stony Creek and Conemaugh River, but other areas are found along the Juniata River and its tributaries. It is an alluvial soil, having been formed by the deposition in moving water of soil particles washed from the adjacent shale and sandstone formations. This soil is frequently overflowed, but generally at times when the least damage results to crops.

As the capillary power of this soil is marked and a supply of water is always present in the lower subsoil, there is no trouble from drought. This is the favorite truck soil, and much more of it could be used for this purpose than at present. In many places irrigation can be practiced by piping the water from springs. The areas are nearly all convenient to markets that can dispose of more truck than is produced. Barnyard manure is used abundantly on this land, although some farmers use commercial fertilizers in addition.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of the Huntington fine sandy loam:

Mechanical analyses of Huntington fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17060, 17130.....	Soil	0.8	2.2	8.5	88.1	16.3	22.4	12.4
17061, 17131.....	Subsoil.....	.0	2.8	10.8	88.2	15.3	19.7	13.1

LICKDALE CLAY LOAM.

The surface soil of the Lickdale clay loam, to a depth of 8 inches, is a gray silt loam to clay loam. Beneath this is a few inches of yellowish heavy silt loam or clay loam, which at about 15 inches grades rapidly into a heavy mottled blue, drab, yellow, and gray silty clay, which rests upon brownish, friable, freshly disintegrated shale rock at depths varying from 24 to 30 inches. Some small sandstone fragments are found in areas west of the Allegheny Front, but here the soil is really a phase of the type and differs also in being more yellow in color throughout the soil section.

Under natural conditions there is difficulty in working this soil, as it has a tendency to clod and to run together like a heavier soil.

This type is found in small bodies throughout the area, the largest being situated near Hollidaysburg. It occupies level or very gentle slopes, extending from the hillsides into the stream bottoms. Occasionally a small part may be overflowed. The drainage is insufficient and much of it remains damp or wet the greater part of the year, making it a cold, late soil.

The Lickdale clay loam is made up largely of colluvial material which has been washed from the shale and sandstone formations on the adjacent slopes. The lower parts doubtless represent a mingling of colluvial and alluvial material.

Most of the chestnut and oak timber has been cut off of this soil and the land used for hay, for which purpose it is admirably adapted. Lack of good drainage alone prevents this from being an excellent soil for general farm crops. Its texture and power to

retain moisture are favorable and the effects of fertilizers are lasting. It is believed that shallow open ditches or, where practicable, tile drains would more than repay the expenditure necessary to install them. Lime is applied and appears to be necessary to secure the best yields. At present its greatest value is for growing hay, of which it yields about $1\frac{1}{2}$ tons of good timothy to the acre. Alsike clover is grown to a limited extent, but should be more universally sown, as it withstands the wet conditions better than the other clovers. When moisture conditions are satisfactory, corn yields about 75 bushels in the ear, and wheat and oats give fair yields, although neither crop has a very large acreage.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Lickdale clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17062.....	Soil	0.3	1.3	2.3	9.4	11.6	46.2	28.8
17063.....	Subsoil.....	.5	2.6	4.4	12.8	10.4	35.6	33.4

FRANKSTOWN STONY LOAM.

The surface soil of the Frankstown stony loam is a gray silt loam 6 to 8 inches deep. Immediately underlying this is a floury light-gray silt loam which becomes yellow and more loamy with depth until, at 36 inches, a yellow true loam is found. In some local spots the surface soil may be a loam. A distinct characteristic of this type is its content of 15 to 60 per cent of angular rock fragments the size of large gravel, which are called locally "bastard" limestone. They are composed mainly of a comparatively soft rock, easily cut with a knife. As much as 15 per cent of the same character of stones mingled with chert fragments cover the surface in places. The quantity of the fragments seems to increase with depth, and boring below 24 inches is very difficult. The type is locally called "gravel land."

The Frankstown stony loam is of small extent and is found as a narrow band between the limestone ridge and the Morrison fine sandy loam in the vicinity of Frankstown and north of Duncansville. This band varies from a few rods to nearly a quarter of a mile in width.

This soil has been formed by the disintegration of water limes, fragments of which predominate in the soil. Bed rock usually lies within 3 to 6 feet of the surface. The soil occupies rather steep slopes, usually extending from the top of the limestone ridges nearly to the bottom of the slope, where the fine sandy loam occurs. This

type is considered much better than the sandstone, but not so good as the limestone land, both of which border it. It is easily tilled and is quite generally cultivated. It is devoted to general farm crops, of which wheat and corn yield well. Corn gives 40 bushels, wheat 12 bushels, and oats 35 bushels per acre. The soil seems to be very deficient in organic matter and the topography and drainage is such that the effects of applications of manure or lime are not lasting. This soil could be used for clover for pasturage or mowing, either of which would tend to increase the humus content and prevent washing and leaching.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Frankstown stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17088.....	Soil	3.8	8.0	2.1	8.3	1.5	62.2	20.0
17089.....	Subsoil.....	2.6	7.8	2.8	9.3	8.2	54.1	14.3

DEKALB CLAY.

Under the Dekalb clay are grouped a number of variable areas. Most of the soil is a brown tenacious clay loam or clay about 10 inches deep, resting upon a very hard and tenacious yellow to greenish-yellow silty clay. It contains many shale fragments which give the material a greasy feel. Very fossiliferous shale rock is usually found at a depth of about 24 inches. Some blue limestone fragments occur on the surface, although these are never numerous. The soil may vary widely from this description, as small areas of Dekalb silt loam and shale loam and Hagerstown clay loam are included, but in bodies entirely too small to be mapped.

The Dekalb clay is found in narrow bands in the vicinity of Hollidaysburg and south of Frankstown. It has a rather rolling topography, although nearly all of it can be cultivated. Surface drainage is well developed and artificial drainage is seldom necessary, although the texture is heavy and the structure compact.

The local name "clay land" is given to this soil. It is derived from the upper part of the Clinton shale formation, which is composed of thin strata of limestone, calcareous shales, and clay shales, and the complex interbedding of these formations is the cause of the variable character of the areas mapped under this head.

This is a valuable agricultural soil, and is for the most part under cultivation. Its natural productiveness is high, and while fertilizers are sometimes applied, they are not considered essential to obtain good crops. Considerable judgment is required in cultivating this

soil, because of its heavy texture, the resulting tendency to clod and puddle, and the difficulty of securing a mellow seed bed. For these reasons much of the land is devoted to hay and pasture, and it is admirably suited for these uses. A fair alfalfa field was seen on this soil, and it is believed it could be used to good advantage in growing this crop.

There are no farms which include this soil only, and the yields of crops can be but roughly estimated. Hay produces $1\frac{1}{2}$ tons to the acre, wheat 15 bushels, and corn about 60 bushels in the ear.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Dekalb clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17888.....	Soil	0.6	2.3	1.3	3.4	2.9	50.4	39.5
17889.....	Subsoil.....	.9	3.4	1.5	3.1	3.3	38.7	48.2

CHEMUNG STONY LOAM.

The Chemung stony loam has about 8 inches of chocolate-colored fine loam, carrying dark-colored shale chips, resting upon a subsoil of similar color and texture, though it may be lighter in both color and texture. It is quite friable and is easily tilled, unless it be for the large quantity of flat chocolate-colored stones about $1\frac{1}{2}$ inches thick and from 6 to 24 inches in diameter. In some places, on account of the number of stones in the soil and subsoil, boring to any great depth is difficult, and many of the larger fragments must be removed before cultivation is practicable. In other places the soil is a true loam, but such areas are small and scattered.

An area of this soil extends across the survey in a strip from a point west of Altoona, Hollidaysburg, and Queen, following in general the western boundary of the Dekalb shale loam, with which it is closely associated. It is characterized by rough or rolling topography, and consists of steep slopes descending from high knolls to the stream valleys, and varying in elevation from 1,500 to 1,700 feet. Natural drainage is completely developed, but no effects of erosion were seen. The soil has an open structure, but probably is not very droughty.

The Chemung stony loam, known locally as "black slate land," is derived from the upper half of the Chemung formation, composed of chocolate-colored shale and sandstone. The fine earth is probably drawn largely from the direct weathering of the shales. The sandstone strata, being harder, have weathered less completely and form

the most of the fragments remaining on the surface and in the soil and subsoil.

Little of this soil is under cultivation, but more of it should be cultivated, as it is fairly productive. Although no crop yields could be ascertained, it is rated as slightly better than the Dekalb shale loam. It is probably suited to fruit, although none is grown on a commercial scale. The prevailing timber growth is oak and locust.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Chemung stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17866.....	Soil	5.7	6.2	2.0	4.0	11.0	47.9	22.4
17867.....	Subsoil.....	4.9	7.6	1.7	4.4	9.8	45.9	25.3

ROUGH STONY LAND.

Rough stony land represents land where agricultural pursuits have never been and probably never will be carried on to any appreciable extent. Areas of this kind occur on the precipitous slopes along the Conemaugh River and its branches, on the steep slopes of the Allegheny Front in the Johnstown quadrangle, and on the mountainous ridges on each side of Morrisons Cove. Many large rock fragments are found in these rough areas, the removal of which would be next to impossible, and even if this could be done the topography is unfavorable to the cultivation of crops. The fine earth of this type may be of any texture or color.

These lands are by no means valueless. In many places the stone is taken out for building purposes and as ganister rock, and many small farmers derive their principal income from the sale of these rocks.

The lands should be used for forestry, and although a great deal of timber has been removed, some is still standing. Chestnut, oak, beech, hickory, birch, and jack pine are the trees usually found. Much of the forest is in bad condition, though there is every reason to believe that with careful management valuable timber could be obtained from most of these areas.

MEADOW.

Meadow is the term applied to the soil occurring in narrow stream bottoms. It is usually a clay or clay loam in texture, bluish drab in color, though in quite small areas, as along Bobs Creek in the vicinity of Pavia, the soil is a red sandy loam. It is composed of the finer soil

particles from the adjacent shale, sandstone, and limestone formations. It has very poor drainage and is used mostly for hay or pasture. Unless drained it could hardly be used in any other way. If drainage were improved it would be a very good soil for the general farm crops.

STEEP BROKEN LAND.

There are certain isolated areas, mainly adjoining the Dekalb silt loam, where erosion has been so active and the approach from the streams to the uplands is so steep that agriculture can not be profitably practiced on them. Such areas have been indicated on the map as Steep broken land. The soil is usually very similar to the Dekalb silt loam, though possibly somewhat heavier in texture, and generally shallow. It is derived from the Conemaugh shale, but few stones larger than small shaly chips occur either on or in the soil. Drainage is usually excessive.

The type is of little agricultural use except for pasture. The timber, hemlock and locust, is valuable, and areas where there is a covering of forest are worth as much or more than those that have been cleared.

SUMMARY.

The Johnstown area is situated south and west of the center of Pennsylvania and is about 714 square miles in area, forming an oblique parallelogram across the counties of Cambria, Bedford, and Blair.

The area has three natural physiographic divisions, viz, the Allegheny Plateau to the west, the Allegheny Front in the middle, and the Appalachian Valley region to the east.

A stream system is established on each side of the Allegheny Mountains, which form the main watershed of the eastern United States. The Juniata River is the main stream of the eastern section, the Conemaugh River of the western section. South Fork, Stony, and Blacklick creeks are important minor streams.

The first permanent settlement was made at Frankstown in 1756 by Stephen Frank. The pioneers were largely Irish, Welsh, and Scotch. The development of the mines and dependent manufactures caused a rapid increase in population, which centered in the cities of Johnstown and Altoona. The rural population has increased more slowly.

Transportation facilities to the city markets are of the best, consisting of good railroads and, for the most part, of good country roads. Martinsburg, Williamsburg, Hollidaysburg, Ebensburg, and Cresson are towns which depend wholly or in part upon the agriculture of the area.

The wide range in elevation is largely accountable for the different climatic conditions. Johnstown, at an elevation of 1,177 feet, has an average annual temperature of 51.3° F., while at Cassandra, 623 feet higher, it is 47.8° F. The temperature may differ therefore considerably over the area, but there are normally a sufficient number of days in the growing season to mature all farm crops except corn planted late or on very high places. Rainfall is abundant and well distributed throughout the year. The normal precipitation is about 43 inches annually.

With the decline in lumbering a general line of farming was developed and in the eastern part of the area this is still the prevailing system, although stock farming, which includes dairying and raising horses and swine, has been introduced in Morrisons Cove with marked success. General farming has given way to trucking near the cities of Johnstown, Altoona, and Hollidaysburg. Potatoes, cabbage, strawberries, and all truck crops are produced, and the demand is apparently greater than the supply. General farming is practiced on the farms farther removed from towns.

The general rotation of crops is corn, wheat, oats, and hay, consisting of timothy or clover or both. Buckwheat is introduced into the rotation upon the failure of corn to make a good stand. Alfalfa is grown on a number of the soil types and bids fair to become an important crop. Silos are rapidly gaining favor and the number is increasing on the dairy farms. Apples, peaches, pears, and plums also are a source of revenue in certain sections.

Commercial fertilizers, especially high in potash, are used throughout the area. Lime is applied wherever it can be secured without too great cost, and barnyard manure is universally saved, and if possible obtained from sources outside the farm. It is considered the most valuable fertilizing agent.

More attention should be given to the maintenance of humus in the soil to aid in the conservation of soil moisture, prevent leaching, and increase crop yields. Systematic forestry is to be recommended on the nonagricultural lands, which are of considerable extent in this area.

There are three classes of soil in the area, residual, alluvial, and colluvial. The residual soil occupies the uplands and is the most extensive. The rocks from which these soils are derived are sandstone, shale, and limestone. The sandstones and shales give rise to two soil series—the Dekalb and Upshur series. Six types of the Dekalb series were mapped, of which the Dekalb stony loam is the most extensive.

The Dekalb stony loam is cultivated only when market conditions are such that it pays to rid the land of stones and brush. The most of it is in timber, to which it is best suited.

The Dekalb silt loam is the soil next in extent and is used extensively for general farming and trucking, the kind of farming depending upon nearness to markets and conveniences. It is a fairly good potato, cabbage, hay, oats, buckwheat, and wheat soil.

The Dekalb shale loam is used for general farming and produces crops equal to the silt loam when well handled, and is better than that soil for fruit.

The Dekalb loam is a valuable soil, usually lies well, and is admirably adapted to all the crops of the area.

The Dekalb stony sandy loam is not used for farming, and can probably be made to yield better returns if devoted entirely to forestry.

The Dekalb clay, though of limited extent, is a valuable soil and is for the most part under cultivation.

Of the Upshur soils the Upshur stony loam is the most extensive and one of the best fruit soils in the area, but is little developed. General farming, trucking, and forestry are all practiced to some extent.

The Upshur loam is of small extent and little of it is cultivated, although it is a strong soil.

The Upshur stony sandy loam covers a considerable area, but is suited only for forestry.

The miscellaneous soils of residual origin are the Chemung stony loam, Frankstown stony loam, Morrison sand, Morrison sandy loam, and Morrison fine sandy loam. The most of these types are of small extent and relatively little agricultural importance. The Morrison fine sandy loam, however, is used largely for trucking and general farming.

The soils derived from limestone belong to the Hagerstown series, in which the Hagerstown silt loam is the most important. This is the best soil in the area for general farming, being particularly adapted to corn, oats, and wheat. Dairying and apple orcharding are also extensively practiced.

The Hagerstown clay loam is naturally the most productive soil of the area, but is of small extent.

The Hagerstown stony loam is only cultivated after removal of the chert fragments, which is often expensive and difficult, and does not compare with the other limestone soils in agricultural value.

The Hagerstown sandy loam is of limited occurrence, but is valuable for producing general farm crops.

The alluvial soils are largely included in the Huntington series.

The Huntington fine sandy loam occurs immediately along the streams and is the most valuable trucking soil in the area.

The Huntington loam lies farther back from the streams, and is suited to general farming as well as to truck. Of the truck crops tomatoes do particularly well.

Meadow is used mostly for hay or pasture, and unless drained is unsuited for other purposes.

The Lickdale clay loam is the only type which belongs to the colluvial class, and small isolated areas are common. Naturally this is not a productive soil, but when drained and improved it is a most valuable type for hay and general farm crops.

Rough stony land and Steep broken land are largely nonagricultural and can only be used for forestry or grazing in some places.

SOIL SURVEY OF THE EASTON AREA, MARYLAND.

By HUGH H. BENNETT, W. E. THARP, W. S. LYMAN, and
H. L. WESTOVER.

DESCRIPTION OF THE AREA.

The Easton area, including the counties of Caroline, Queen Anne, and Talbot, is situated in the central part of the Eastern Shore of Maryland, between the Chesapeake Bay and the Delaware line, and is included within the meridians $75^{\circ} 40'$ and $76^{\circ} 25'$ west longitude, and parallels $38^{\circ} 30'$ and $39^{\circ} 15'$ north latitude. It is bounded on the north by Kent County and on the south by Dorchester and Wicomico

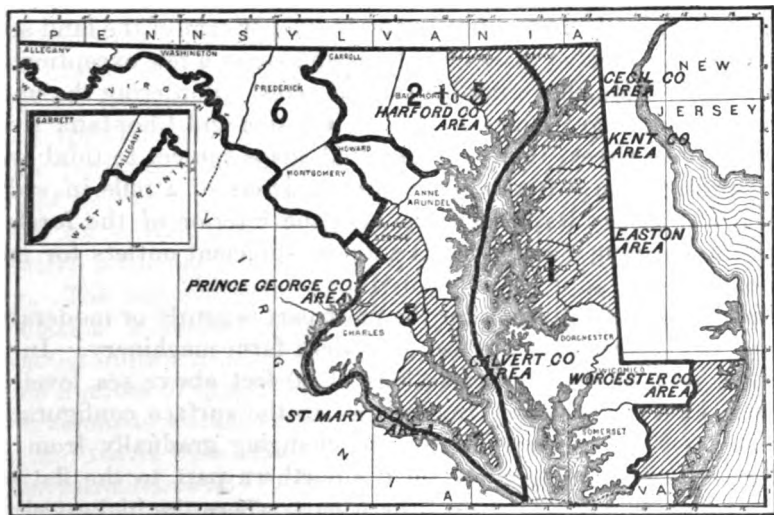


FIG. 3.—Sketch map showing location of the Easton area, Maryland.

counties. Its extreme length from north to south is about 47 miles and greatest width about 34 miles. The total land area is 618,560 acres, or about 967 square miles.

The area lies wholly within the physiographic division known as the Atlantic Coastal Plain. The land surface varies in its topographic features from the nearly flat foreland country bordering the Chesapeake Bay and its estuaries, to the gently and moderately rolling upland plain, including most of the country east of a line drawn from

Chestertown through Queenstown and Easton to Cambridge. Generally there is not an abrupt break between these topographic divisions; the change is more of a gradual rise of the lower division toward the upper plain, the two blending in gentle slopes. However, there is in some places an escarpment of sufficient slope to give rise to considerable erosion. The true lower division lies largely below the 20-foot elevation line and entirely below the 30-foot line. While its surface is for the most part flat, some of it is undulating. This foreland country has been indented by the streams and bays branching off from Chesapeake Bay, which have divided the country into long, narrow peninsulas and islands, making travel by land circuitous. Along the shore of the Chesapeake and its larger estuaries the waves are gradually cutting back the shore line—in some places as much as 20 feet a year—especially where the shore line is precipitous. The eroded material is carried to more protected places and deposited, eventually forming Marsh.

From the very irregular shore line it might be inferred that the foreland country is excessively marshy and unfit for cultivation. Such is far from true, the extent of Marsh being confined to inconsiderable marginal fringes, amounting to 2.5 per cent of the land area. There are in protected places like bays and coves a few exceptionally large bodies of Marsh containing several acres. Bordering the upper sources of the larger streams, like the Chester and Choptank rivers and Tuckahoe Creek, there are marginal strips subject to tidal overflow varying from a few rods to three-quarters of a mile in width. Very few drainage ways reach up into the interior of the foreland plain, thus leaving the flat lands without sufficient outlets for good surface drainage.

The upland plain division for the most part is gently or moderately rolling, and lies well for the use of modern farm machinery. In the northern part of the area elevations of 80 feet above sea level are attained at a few points. Inequalities in the surface configuration become less bold toward the south, changing gradually from the moderately rolling topography in the northern part to the flat and gently rolling country in the southern part, where the highest elevations are about 60 feet. There is a tendency for this upland country to assume more level and unbroken topography toward the interior, where is found a plain more nearly as it existed just subsequent to the emergence of the area. A larger proportion of this interior would be much more poorly drained but for the excellent underdrainage afforded through the porosity of the underlying material. There is considerable country in northern Caroline and eastern Queen Anne counties where the nearly flat surface is interrupted only by low ridges, mounds, and basinlike depressions. Streams have not worked

out good channels in this section, which fact accounts largely for the poor drainage conditions existing in the intervening flat lands.

The channels of main upland streams increase gradually from mere shallow drainage ways near the interior to comparatively deep valleys toward the marginal portion of the upland plain. The sides of some of these are sufficiently steep to have developed, through excessive erosion, a relatively broken surface. Numerous tributaries reach out from the main streams, affording a good drainage system to most of the upland country. The fall of many of the creeks is sufficient to develop considerable power. There are a number of water-power flour mills scattered throughout the uplands. The smaller streams are nearly all bordered by narrow strips of low, wet ground extending from mouth to source in the uplands, where considerable areas of flat, poorly drained land, sometimes semiswampy in character, are found. The larger streams flow very sluggishly in a general northeast-southwest direction.

The Chester and Choptank rivers are navigable to points near the Delaware line. The Tred Avon, Miles, Wye, Back Wye, and Corsica rivers are wide and navigable nearly to the head of tidewater, where they suddenly narrow to small streams which reach comparatively short distances into the uplands.

Talbot County was organized under the provincial government about 1664 and included the present domain of Queen Anne, considerable portions of Caroline and Kent counties, and nearly all its present territory. Later the county was divided, and from it Talbot, Queen Anne, Kent, and Caroline counties were formed.

Active settlement began about the middle of the seventeenth century. The settlers were mainly English, from whom the present population is largely descended. The "toleration act" of 1649 attracted quite a number of religious refugees, among them a considerable number of Quakers from Virginia and New England. Most of these colonists settled within sight of navigable water. Transportation and travel were mainly by water.

The farmhouses and outhouses are quite substantial, and the fields are effectively fenced with wire or osage-orange hedges. Churches and schools are conveniently located. The highways are excellent in summer and good in winter over most of the area surveyed.

The largest towns, Easton, Centerville, and Denton, are the respective county seats of Talbot, Queen Anne, and Caroline counties. There are many other important towns and shipping points throughout the area. The Easton area is exceptionally situated with respect to large markets. From Easton, in the southern part, Baltimore is distant only forty-odd miles by water, while Philadelphia and New York, respectively, are 108 and 198 miles distant by rail, over the

Pennsylvania Railroad. This railroad furnishes the transportation facilities by land for the entire area. Various steamboat lines are accessible from almost any part of the survey, and many freight-carrying sailing vessels ply between the various landings and Baltimore.

Throughout the area there are numerous canning factories, well situated near railroad stations and boat landings. It is estimated that Caroline County alone furnishes 10 per cent of the total tomato pack of the United States. These factories vary in their output from a few hundred cases of tomatoes to about 100,000 cases a season, besides the heavy packs of garden peas, corn, and pears.

CLIMATE.

The appended tables giving the records of weather observations at Easton, near the southern boundary, show a mean annual precipitation of 40 inches for that section. Records of the State weather service indicate variations in the precipitation of the upland country from 39 to 41 inches, and a somewhat higher average for the low foreland division. Rainfall is fairly well distributed throughout the year, although there is slightly more during the summer months of June, July, and August, the average for these months being about 12 or 13 inches. For other seasons the average is approximately 10 inches. The spring of 1907 was unusually wet, and corn planting was delayed about a month. Dry periods in the late summer and fall sometimes bring about a hardened condition in the soil which interferes with the preparation of the land for wheat.

There is very little variation in temperature between the northern and southern sections. There is some moderation in temperature along the water front, where early vegetables are sometimes grown. The mean annual temperature at Easton is about 55° F., while that at Chestertown, just outside the area to the north, is approximately 54° F. The temperature for January and February averages 33° F. and 32.5° F., respectively, and for July the mean is 76° F. In the winter months brief cold spells occur when the zero mark is reached, while in summer the temperature is occasionally 100° F., although rarely going higher than 95° F. The maximum range of temperature at Easton is about 115° F.

The last killing frost in spring occurs usually between the 1st and 20th of April, and the first in fall about the last of October. Early strawberry blossoms and fruit-tree buds, particularly the peach, are likely to be damaged from late spring frost, and sometimes the late tomato crop suffers.

The ground rarely freezes to a depth of more than 6 to 8 inches. Winter crops on the mellow Portsmouth soils, particularly wheat,

are liable to injury on account of the heaving of the surface soil during alternate freezes and thaws. The heavier soils, in particular the Elkton silt loam, frequently are crumbled by alternate freezes and thaws and after rains form a hard, compact, smooth surface. Beyond these tendencies such favorable conditions prevail in the soils during the winter that remarkably little damage is done crops.

During the winter the prevailing winds are from the northwest and north, while in summer the winds blow more often from the south and southwest.

Normal monthly and annual temperature and precipitation.

Month.	Easton.		Chestertown.		Month.	Easton.		Chestertown.	
	Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.		Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.
	° F.	In.	° F.	In.		° F.	In.	° F.	In.
January.....	33.3	2.92	32.0	3.14	August.....	74.9	3.60	73.9	4.99
February.....	32.9	3.93	31.4	3.14	September....	60.0	3.00	67.9	3.63
March.....	43.6	3.53	42.5	3.73	October.....	57.2	3.22	55.9	3.00
April.....	53.2	3.05	51.3	3.63	November....	45.6	2.49	45.2	2.75
May.....	63.9	3.34	63.0	2.89	December.....	36.4	2.99	35.3	.....
June.....	71.5	3.87	71.2	4.01	Year...	54.8	40.44	53.8	.....
July.....	76.5	4.50	76.0	4.34					

Dates of first and last killing frosts.

Year.	Easton.		Chestertown.		Year.	Easton.		Chestertown.	
	Last in spring.	First in fall.	Last in spring.	First in fall.		Last in spring.	First in fall.	Last in spring.	First in fall.
1898.....	Apr. 28	Oct. 28	Apr. 28	Oct. 28	1902.....	.....	Oct. 22	Apr. 4	Oct. 21
1899.....	Apr. 6	Nov. 13	Apr. 11	Oct. 22	1903.....	Feb. 27	Oct. 28	May 1	Nov. 7
1900.....	Apr. 11	Nov. 15	.....	Nov. 14	1906.....	Apr. 3	Oct. 13	May 11	Oct. 12
1901.....	.....	.....	.....	Nov. 21	Average.	Apr. 3	Oct. 3	Apr. 23	Oct. 31

AGRICULTURE.

Since its earliest settlement the Easton area has been preeminently agricultural in its pursuits. In the early days little more corn and wheat were produced than sufficed to supply the wants of the colonists, and in unfavorable seasons there were periods of distress from short crops.

At first tobacco was grown almost to the exclusion of other crops, and was long the medium of exchange. There were six tobacco warehouses in Talbot County in 1775, but with the beginning of the nineteenth century the tobacco acreage had enormously decreased, and warehouses were little used. The larger planters shipped their tobacco to England, but the smaller planters traded with the local

representatives of English houses. Warehouse receipts representing the quantity of tobacco stored, like tobacco, passed as money.

The Revolutionary war hastened a change in agriculture by cutting off the export trade with the mother country and creating a demand for cereals to feed the Provincial army. Prior to this, however, farmers had begun to realize that their lands were being impoverished by cultivation to one crop and were increasing the acreage of wheat. Clover and timothy were coming into favor and were rotated with cereals. It was about this time that the present three-field system of cropping appeared. Flax was grown for the fiber until some time before the civil war. Sweet potatoes have been produced on a small scale since the earlier days. Peaches began to be a crop of considerable importance about sixty-odd years ago. Cultivation of tomatoes for canning purposes began about 1872, when one of the first canning establishments was put up at Greensboro. Rye has never been an important crop, though a few thousand bushels were grown annually for a time in Caroline County.

From 1859 the production of oats decreased until 1879, since when the crop has not had an important place in general agriculture. This crop too often has suffered from unfavorable weather conditions in June and July, filling out poorly.

The production of wheat has increased steadily and on a fairly profitable basis in spite of western competition. The total yield for Caroline, Queen Anne, and Talbot counties in 1849 was 498,845 bushels, while in 1879 Talbot County alone produced nearly as much as this and in 1899 the total for the three counties was 2,150,460 bushels, Talbot County leading with over 800,000 bushels. Owing to more thorough preparation of the seed bed and to the freer use of manures there has been a marked increase in the average yields of wheat within the last twenty-five years.

Corn also has shown a steady increase. The production in 1849 for the three counties was 1,656,659 bushels. By 1879 it had increased to 2,139,680 bushels and in 1899 to 2,610,940 bushels. Of this total Queen Anne County produced nearly one-half.

The value of live stock increased from \$900,312 in 1849 to \$1,744,589 in 1879. In 1899 the value of live stock was \$579,514, \$1,049,553, and \$759,581 for Caroline, Queen Anne, and Talbot counties, respectively.

Fertilizer expenditures varied from \$87,548, \$158,977, and \$110,001, respectively, for Caroline, Queen Anne, and Talbot counties in 1889, to \$93,290, \$130,330, and \$89,040, respectively, for the same counties in 1899. The decreased expenditures, as shown for Queen Anne and Talbot counties, mean rather a decrease in the quality and price of material than any decrease in quantity. It appears that the quantity used has steadily increased since the introduction of this class

of fertilizers following the civil war, and the indications are that in quantity, at least, there will be no marked decrease in the near future.

There were very few large plows in the area prior to the early seventies. Up to that time ridging for corn had been the practice. Since the introduction of the large chilled plows the practice has largely disappeared and the soils have been prepared deeper and more thoroughly. The three-field system, corn, wheat, and grass, had been the prevailing rotation up to the time of the introduction of this plow. The farmers are slowly growing less corn and wheat and practicing more diversification. More stock is being raised, more grass and forage crops grown, and more corn cut for shredding. The heavier, better drained soils are so well adapted to wheat that the crop continues to hold an important place. Farms are gradually being reduced in size, a fact which in itself points toward more intensive methods of farming.

At present the dominant system of agriculture practiced over a very large proportion of the area is general farming in connection with more or less trucking. On most farms situated within 4 or 5 miles of a cannery or boat landing, tomatoes are grown as an important crop, and often sugar corn, garden peas, and pears are grown for canning, while peaches, pears, asparagus, strawberries, and dewberries are grown for market. In the vicinity of Ridgely trucking is equally as important, or even more so, than general farming.

There are no farms devoted exclusively to dairying, although a number of farmers sell milk at the local markets or at the few creameries. A small number of the farmers are using separators, selling the cream to the creameries or shipping it and feeding the skimmed milk to hogs.

Hogs are raised to supply the home and local market demands. Poultry and sheep are considered important additions to general farming, especially in certain localities like Kent Island. Most of the draft animals are raised on the farm.

Of the total acreage of land cultivated to crops in Queen Anne County, about 55 per cent is seeded to wheat and 35 per cent to corn, with grass and miscellaneous vegetables next in importance, in the order named; in Talbot County about 60 per cent of the cultivated area is seeded to wheat, about 25 per cent to corn, and the remainder to grass and miscellaneous vegetables, principally tomatoes; and in Caroline County about 40 per cent to corn, 35 per cent to wheat, and the remainder about equally divided between miscellaneous vegetables and grasses. About 65 per cent of the total acreage cultivated to miscellaneous vegetables is used for tomatoes. The bulk of this crop is sold to local canneries, although a considerable quantity is

shipped by boat to outside canneries. Most of this season's crop (1907) is contracted for by the local canneries at about \$9 per ton. The variety most generally grown is the Stone—a medium large, uniformly ripening, prolific variety, possessing the red color and fleshiness desired for canning purposes.

Considerable quantities of garden peas, sugar corn, and Kieffer pears are handled at the canneries. The Kieffer, the most successful pear grown, and a wonderful producer, is better suited to canning than marketing. Strawberries, raspberries, and dewberries of excellent quality do well on the lighter soils. Strawberries grown in the vicinity of Ridgely have a good reputation in northern markets. The crop proves immensely profitable in years of short crops of strawberries elsewhere, and on the average a good margin of profit is realized. The Lucretia dewberry proves very successful, especially on the lighter soils of Caroline County. Wild huckleberries thrive on the light soils and considerable quantities are gathered for market. Good sweet and Irish potatoes are obtained on the light types. A dry, mealy sweet potato of good keeping quality is grown in Caroline County on a small scale for marketing.

For many years the peach crop was very profitable throughout the area, but owing to ravages of disease, particularly the "yellows," the industry has declined. The trees, unless diseased, make a rapid growth and produce abundantly in favorable years. Some orchards have not been injured—those near the water front seem especially resistant to disease. The crop is yet of considerable importance and orchards are still being set out, perhaps more generally in Caroline County than elsewhere. The Elberta appears to be the favorite variety at present, although numerous varieties are grown. Farmers should watch their orchards closely and burn, root and branch, every tree as soon as the first indications of the "yellows" are noticed. Some good varieties of summer apples are grown for home use. Of the late varieties the Winesap, Ben Davis, and York Imperial have proved well suited to the soils and climate. It is believed that the Stayman Winesap, which is being successfully grown on similar soils in Delaware, would prove a profitable variety on the Sassafras loam and sandy loam. Scarlet clover is grown as a soil renovator and occasionally for seed. More cowpeas should be grown for seed, especially on the lighter Sassafras soils.

Notwithstanding that the better crop adaptations of soils are pretty clearly understood, there is too little specialization to accord with soil variation. Farmers everywhere recognize that the Elkton silt loam is a poor corn and tomato soil, though a fair soil for wheat and grass, yet all these crops are indiscriminately grown on it. Although average yields of corn on this type are poor, in favorable seasons the crop does well, and it is with the expectation of such a season

that farmers put in a considerable acreage every year instead of increasing the acreage of wheat and grass and keeping more stock.

The Sassafras loam and silt loam are admirably suited to wheat, corn, and grass, while the Sassafras sandy loam averages excellent yields of these crops. An inferior quality of wheat—small kernels—is expected on some of the poorer drained phases of these types. It is claimed, however, that the quality of that grown on the Elkton and Portsmouth soils is generally very good. Tomatoes do best on the Sassafras sandy loam, although the Sassafras loam makes good average yields, while the Sassafras silt loam makes a fairly good late crop. In growing tomatoes for canning there is no particular purpose in getting an early crop, except to head off frost. The canneries begin in August and run until the crop is canned. Strawberries and dewberries do best on the Sassafras sandy loam, Portsmouth sandy loam, and Portsmouth loam, and these types when available are generally selected for these crops. The Sassafras sand and loamy sand are particularly suited to garden peas, asparagus, turnips, early tomatoes, and Irish and sweet potatoes. Cultivated chestnuts do well on these soils.

The clovers do best on the better drained heavy soils. Red clover frequently dies out and is being replaced by crimson or scarlet clover and alsike. Timothy does well on the heavier soils, but should be grown in rotation with other crops. The well-drained, heavier Sassafras soils produce good crops of alfalfa. The subject of crop adaptation is taken up more in detail under the heads of the different soil types.

While most farmers practice some system of rotation, there are others who grow corn or wheat on the same land several years in succession. Under this treatment some of the fields have decreased in yield, but only a small proportion of the area has been subjected to such injudicious treatment.

The prevailing schemes of crop succession—the old three and five field systems—are very well suited to the Sassafras loam, sandy loam, and silt loam, which types constitute about 70 per cent of the cultivated acreage. These systems include the following rotations: Corn, wheat, and grass for the three-field system, and corn, wheat, grass, wheat, and grass for the five-field system. The grass consists of timothy and red clover or timothy alone, and is usually cut once and then left for grazing. Tomatoes fit in well after corn and are followed by exceptionally good yields of wheat on account of the excellent physical and moisture conditions induced in the soil by the shading of the vines and the good manurial properties of the vines and refuse fruit. It is estimated that wheat following tomatoes or a timothy-clover sod will yield an average of one-third more than if it follows corn. Tomatoes do not do so well after tomatoes. Rotations on all the types

except, perhaps, the Portsmouth soils, should include crops of cow-peas or clover to be turned down green in conjunction with applications of 25 to 50 bushels of lime per acre once every three to six years, according to the condition of the soil and its power to retain organic matter. On account of the more thorough aeration of the lighter types, like Sassafras sand and loamy sand, the organic matter is likely to be depleted rapidly owing to rapid oxidation, and it is therefore necessary to grow frequent crops of cowpeas, but not so much lime is required as on the heavier soils. Good results are secured by liming grass in the fall preceding breaking for corn or wheat. Direct applications of lime to grass should be light (20 bushels to the acre), for the reason that too rapid decomposition of the turned-under vegetation results from large applications. In case large amounts of lime are used, the applications should be made to the broken soil so as to keep the lime from direct contact with the vegetable matter. A good many farmers are beginning to sow cowpeas or crimson clover in corn or crimson clover in tomatoes at the last cultivation, turning these under before planting wheat. The practice of turning under green crops obtains more generally throughout Caroline County than anywhere else in the area. Here the practice has proved invaluable in building up the soils, both in connection with general farming and trucking.

Much trouble in getting good crops by employing the old method of seeding red clover on wheat in late winter is experienced. The young, tender plants, suddenly exposed to hot sunshine by cutting off the wheat close to the ground, seem to be unable to withstand the change and gradually die out. In seasons with plenty of moisture and no protracted hot spells succeeding harvesting, good crops are secured. Contrasting the clover yields obtained in the earlier days by sowing with wheat, and the good crops now obtained on the newly cleared peach orchards, with the crops obtained on other soils, it appears that the latter may have come into an unhealthy condition with respect to this crop. However, with an increased yield of wheat and consequent heavier growth and denser shading, the young plants are crowded nearer together and probably are less strong upon removal of the grain than formerly was the case. Some attribute the failures to toxic effects coming from continued use of acid-phosphate fertilizers. On the other hand there are many instances where good crops have been secured by seeding alone in the fall on thoroughly prepared limed ground. Many farmers claim they have no trouble in getting good crops by liming after breaking sod land, sowing wheat, topdressing with good barnyard manure, and then sowing the clover on the wheat in late winter or early spring. Scarlet clover can be grown with ease on most of the types, but the hay is not considered as good as red clover hay. Cowpeas can be grown on all soils, even

those too light for crimson clover, and always improve the land, whether cut, grazed off, plowed under, or left as a winter cover crop. Alsike clover, which is rapidly coming into favor, will prove a valuable crop for this region. By growing cowpeas land too light for clover can be brought up to good condition for that crop.

Large quantities of commercial fertilizers are used. Fertilizers used for tomatoes, potatoes, asparagus, and corn average about \$17 a ton in price and vary considerably in analysis, running generally from a "10-5" phosphate potash to about a "8-2-4" brand:

As a general rule, readily soluble, "quick-acting" fertilizers which produce an early growth and early ripening of the crop are most desirable. If nitrogen is needed, nitrate of soda is perhaps the best form in which it can be applied. It acts quickly but not through a long period, and for that reason is very desirable where short-season crops are concerned. In many cases it is found an advantage to apply the nitrate at two periods rather than all at once. It is well to make one application when the plants are set in the field and a second about the time the fruits begin to color. Fertilizers containing nitrogen in a slowly available form, such as cotton-seed meal or coarse, undecomposed stable manure, which do not stimulate an active growth until late in the season, are not desirable for this crop. Such fertilizers are too slow for a short-season crop like the tomato, which needs something to stimulate it at the very time it is transplanted to the field. Such fertilizers also tend to stimulate late growth of vine at the expense of the maturity of the fruit. Potash and phosphoric acid are more conducive to the development of fruits than is nitrogen, except in the form of nitrate of soda.

Heavy dressings of stable manure tend to produce too much vine, and are seldom or never employed. If stable manure is used it is at a moderate rate, usually not more than one or two shovelfuls to a plant. This, if well decomposed and thoroughly incorporated with the soil, is very stimulating to the young plant and consequently very beneficial.

Any fertilizer used should be applied, in part at least, at the time the plants are transplanted to the field.^a

Fertilizers for wheat and grass vary in cost from \$12 to about \$18, averaging in composition about "9-1-2." Very little sodium nitrate is used. Kainit is used frequently on the Elkton soils to prevent "frenching." About twenty years ago considerable "black residuum" was used to prevent "frenching," and it is claimed with good results. This material, composed of charred leather, undecomposed scrap iron, and traces of muriate of potash, the residuum left in the manufacture of potassium prussiate, probably improved the structure of the soil and acted as an absorbent. It is said that phosphates help ripen crops and even force out a large number of "underlings" or stool stalks.

Fertilizers are applied at the average rate of about 300 pounds an acre for wheat, 200 pounds for corn, and 400 pounds for tomatoes. Heavier applications are made for crops like asparagus, garden peas, etc. Although commercial fertilizers are not as generally used for corn as for wheat, the bulk of barnyard manure is used for corn.

^a Farmers' Bulletin No. 220, p. 12.

Experience of the most successful farmers shows that fertilizers are more lasting and beneficial when applied in conjunction with vegetable manure. Nitrogen, the most expensive ingredient of fertilizers, should be secured by growing cowpeas and clover, which crops gather atmospheric nitrogen through the action of bacteria living in the root nodules of these legumes. Alfalfa also stores up nitrogen in the soil. Too little home mixing of the fertilizer ingredients is done. Farmers generally buy from agents for future delivery.

Barnyard manure is the best fertilizer for general use on the soils of this section. Moderate amounts are made by using wheat straw as bedding material, though generally not enough to cover the land intended for corn. Considering the excellent quality of this form of manure and the ease with which heavy yields of forage crops can be produced, it seems strange that stock raising has not been carried on on a more important scale. A large extension of the stock industry undoubtedly would prove profitable. It should be the object to feed the bulk of corn and increased quantities of hay and forage crops to stock, carefully preserving the manure and returning it to the land. By establishing more cooperative creameries at convenient points throughout the area, butter making could be introduced on a profitable and permanent basis.

Farmers frequently claim that the soils are not well enough adapted to grass for profitable dairying. The yields of hay from the heavier types—from 1 to 2½ tons per acre—compare favorably with those of some of the most prosperous butter-making sections, and further, there could not be found anywhere soils better adapted to forage crops. It is not necessary to have a large acreage of pasture land where such yields of these can be secured. Silos, a comparatively small acreage of mixed grasses for pasturage, and a large acreage in cowpeas, clover, sorghum, timothy, etc., would solve the problem of feeding.

For wheat, breaking begins on stubble and sod land in late July and in August, and "corn land" is broken as soon as the crop can be removed. After breaking to a depth of 4 to 6 inches with a walking moldboard plow drawn by two or three horses, according to soil conditions, the ground is rolled with heavy iron rollers, then run over several times in opposite directions with spike-tooth and spring-tooth harrows and occasionally with a smoothing, an acme, or a disk harrow, then rolled again and seeded. It is a good idea to get the soil sufficiently pulverized for a hoe-drill to do good work, although it is not necessary to use this kind of a drill. Sometimes farmers get behind to such an extent that there is not sufficient time for giving corn land thorough preparation. Fairly good results are obtained by simply disking and seeding. Such land, however, is more inclined to run together and harden the following spring.

Most of the wheat crop is put in during the first half of October, although seeding sometimes begins as early as the middle of September and continues up to about the 1st of November.

Land for corn is plowed to an average depth of about 5 inches, rolled and prepared about as for wheat, then planted in checks, generally between April 20 and the middle of May. The heavier soils could be put in better condition by breaking in the fall, so as to expose the soil to the action of freezes and thaws. Especially is this beneficial for sod that has been packed by grazing or is in an unfavorable structural condition through depletion of its organic matter. However, such fall preparation for corn sometimes conflicts with the seeding of wheat and care of the late crops of tomatoes. Corn is cultivated comparatively deep the first two or three times with a "buggy cultivator" or walking cultivator, then shallower with a walking cultivator. This frequent flat cultivation is sufficient for all needs of the crop. There is a custom of cultivating every other middle in going over a field after surface roots begin to form. The object is to avoid retarding growth by leaving one-half the surface roots uninterfered with until those in the cultivated middle have time to recuperate. Corn is either cut and shocked in the field or stripped of the lower blades and topped, leaving the ears to be pulled. The wide corn-shock rows are sometimes seeded to oats in late winter or early spring. Very little wheat is stacked, thrashing being done from the shock.

Tomato land is prepared and the crop cultivated about the same way as corn. The general plan is to set the plants close enough to allow them to mat and completely shade the land, thus protecting the soil and fruit from the hot sun. Fall plowing would be the better plan, except on the Sassafras sand and loamy sand. Strawberries are cultivated in matted rows. The middles are cultivated shallow in July or August, while weeds and grass are removed by hoeing and by hand.

Whenever possible fall plowing should be practiced for all crops on all soils, except the Sassafras sand and sandy loam, which would not be particularly benefited except by turning under vegetable matter. The depth of plowing should vary and should be generally increased to 7 to 10 inches, care being taken not to increase the depth more than an inch or two in one season. When more than this amount of the under soil is turned to the surface injury is sometimes done succeeding crops, owing to the fact that the lower soil or subsoil does not have time to weather out and get in good condition during winter. This is especially true with the Elkton soils and the poorer drained phases of the heavy Sassafras types. There are instances where suddenly turning up a large quantity of the subsoil has injured land for years. The depth of plowing should not be increased materially

in the spring with the intention of growing a crop that season. Applications of lime immediately following deep plowing hasten improvement in the exposed subsoil material.

Farm hands hired by the month are given \$15 and board. It is believed the tomato industry would be considerably extended were day laborers more numerous. A good many Bohemians and Poles from Baltimore work in canneries. Labor-saving machinery is helping to solve the labor problem, as the land is well suited to such modern machinery as wheat and corn harvesters, sulky and gang plows, manure distributors, wide harrows, etc. An extension of stock raising and a reduction of the acreage of those crops that require the most labor would make the problem still simpler.

About 55 per cent of the farms of Caroline County, 50 per cent of those of Talbot County, and 40 per cent of those of Queen Anne County are operated by owners, the remainder being cultivated largely by share tenants. The share tenant pays one-half the fertilizer and seed bill and receives one-half of the crops. Land is rented for one year. Landlords generally have a voice as to the acreage that shall be planted to different crops. Wheat and corn are by agreement more exclusively planted. Too often the grass area is restricted and the number of stock kept too limited for the production of a reasonable quantity of manure. A considerable number of rented farms could be managed more providently with respect to soil improvement. This is sometimes neglected, owing to the lack of interest on the part of the tenant or because the landlord is too interested in immediate returns in wheat or corn. The average size of farms in 1899 was about 100 acres for Caroline County, 137 acres for Talbot, and 153 acres for Queen Anne. The price of land has increased considerably in the last fifteen years. Acreage valuation varies widely—from \$30 to \$60 for average farming land—according to the character of the soil, state of improvements, and locality. Land can be bought at lower figures on some of the poorer drained or deep sandy soils not within easy reach of shipping points, while, on the other hand, some of the water-front and suburban farms can not be bought at \$100 an acre. The price of land has often been influenced by the price of wheat and corn.

SOILS.

The superficial geology of the region is comparatively simple. The two main topographic divisions previously described as the lower foreland and the upland country comprise, respectively, the Talbot and the Wicomico plains, geologic terms applied to the younger and older series of beds of unindurated materials from which all the soils of the area have been derived. These divisions belong to the Columbia group of Pleistocene deposits, and their ele-

vation to the present altitude above sea level is comparatively recent in a geological sense.

The chief soil-forming materials of both the Wicomico and Talbot formations are sand and silt, the latter being made up of soil grains ranging in sizes between very fine sand and clay. The former is the dominant constituent of all the Caroline County soils and those of the contiguous northeastern part of Queen Anne County. Silt is the most prominent constituent in the soils of the "necks" and foreland country and of many areas, especially the flat stretches, in the uplands west of the Choptank River.

The underlying or substratum materials usually consist of sand or sand and gravel much coarser than the constituents of the overlying mass. Below a depth of about 3 or 4 feet such beds of coarse material frequently alternate or are interstratified with beds of silty clay, fine sand, coarse gravel, etc. In some sectional exposures there are exhibited alternating strata of various thicknesses—from thin seams to 2 or more feet—presenting great variety in texture and color. At Downes Landing, in Tuckahoe Neck, in a vertical exposure of about 15 feet, there can be seen some twenty distinct strata, which separately include silty clay, clay loam, silt loam, coarse, medium, and fine gravel, coarse, medium, and fine sands, sandy loams, fine sandy loams, and gravel and sand mixtures, covering nearly the whole range of soil classes. Cross bedding and interstratification is common in those substrata where sand is the chief constituent, as is shown in a section near the Baltimore, Chesapeake and Atlantic depot at Hillsboro. The character of these lower materials does not, as a rule, affect the character of the soil, except as regards drainage conditions.

The source of most of the superficial material undoubtedly is the glaciated region and the region of crystalline rocks to the north. The sand does not have the appearance of being an old sand; it has not suffered an extreme degree of weathering. The quartz grains are subangular or much less rounded, generally, than the worn grains of some of the older Norfolk sand of the Coastal Plain region to the south, and minute mica flakes, grains of feldspar, magnetite, and fragments of dark-colored rocks are fairly abundant. Erratic boulders occur here and there in northern Queen Anne County, decreasing in number toward the south.

The silt deposits have a marked resemblance to some of the loess of the Mississippi Valley, particularly in structure, texture, and color. This material is of common occurrence at all elevations, but east of the Choptank River it loses its identity as a stratigraphic unit, being simply a component of the more abundant coarser soil material. There is very little silt in the deep sand deposits that occur along the east banks of the river and larger creeks, but as the distance from the streams increases the silt content of the soils increases.

Erosion, weathering, and drainage have been the most potent factors in the modification of the original material. The rate of erosion has been restricted in a large degree by the general slope of the surface and the original heavy forest growth. Except in case of stream alluvium and the hummocky soils in the region of northern Caroline County, where there are evidences of soil movement through the agency of wind, erosion has been limited to a comparatively slow movement or gentle shifting of the superficial materials in the direction of the surface slope. The finer materials are moved faster than the coarser ones, and therefore a tolerably definite relationship exists between the soils and the topography. The lighter soils are found on the slopes, while the heavier soils occur in the more nearly level areas; but the transition from one type to another is always a gradual one. On broad areas of comparatively level land, where little or no surface wash has taken place, the texture has been determined by the character of the originally deposited material.

The various types are quite regular in profile, uniformity of texture, and structure, irrespective of topography or geological relationship. Generally, the surface foot carries more coarse material and is not as compact as the portion between 12 and 30 inches, and the section below 30 inches is much coarser and more open than the overlying mass. The brown color of the soil and the reddish-brown or reddish-yellow colors of the subsoil tend to give way to grayish in the soil and more nearly yellow in the subsoil toward the south.

Wherever topography and texture have combined to insure good natural surface and underdrainage, the iron content has reached a higher degree of oxidation and the soil grains have been stained brown, reddish yellow, or reddish brown. These colors in the soil and subsoil invariably indicate that condition of mineral and organic constituents which may be considered the normal state of a good, productive soil in this region. Such thoroughly aerated and oxidized soils have very few if any undesirable chemical or physical properties and are well suited to general farming. All the soils of this character have been grouped in the *Sassafras* series. They are the most productive and easiest managed soils of the area.

Where more or less swampy conditions have prevailed, decaying vegetable matter has accumulated, usually in sufficient quantity to form an appreciable part of the soil mass. As is common in such wet, boggy places, the accumulated vegetable matter is very black and occurs in varying stages of decomposition, from slightly changed to well decayed, mingled with earthy material, so as to make a sponge-like mass. Under natural wet conditions such soils are unsuited to most cultivated crops, but owing to the fact that the organic-matter content is otherwise in good condition, drainage only is required to bring these into good crop-producing soils. Owing to the saturation of the subsoil, air has been excluded and naturally this lower mate-

rial is in an unoxidized condition not very unlike that obtaining in the deeper portion of the Elkton soils. These black soils have been assigned to the Portsmouth series.

In those wet and depressed areas where the surface drainage, and generally the underdrainage, has been imperfect, the original material, subjected to intermittent wet and dry stages, has undergone unfavorable structural and chemical changes; the organic matter, though considerable in amount, is in an unfavorable condition, and the soils have turned almost white in color. Through lack of aeration the finer particles have combined rather than granulated, forming a compact, clammy mass. The absence of brown and red colors shows the iron to be in a low state of oxidation. These abnormal processes of weathering have combined to veil the properties of the original material and to bring about changes unfavorable to the development of a good agricultural soil, giving rise to the distinct series of Elkton soils. These Elkton soils stand between the Sassafras and Portsmouth soils as a transitional series that has been derived from the same material but subjected to different processes, or rather abnormal processes, of weathering.

In this series grouping of the soils according to their most prominent characteristics of color, drainage condition, organic-matter content, productiveness, structure, etc., no account has been taken of the textural differences due to the various sizes or grades of the constituent soil grains. However, to assist in a more specific and clearer treatment, the several series have been divided into classes—sands, sandy loams, fine sandy loams, loams, silt loams, etc., according to their respective textures or relative content of coarse, medium, and fine sand, silt, and clay, as shown by mechanical separation and weighing of the various constituents of representative samples.

The following classification shows the soils of the area grouped according to processes of weathering or alteration in the original marine sediments:

	{	Sassafras gravelly loam.
	{	Sassafras sand.
	{	Sassafras loamy sand.
Soils formed under good drainage conditions.....	{	Sassafras sandy loam.
	{	Sassafras fine sandy loam.
	{	Sassafras loam.
	{	Sassafras silt loam.
	{	Elkton sandy loam.
Soils formed under intermittent wet and dry drainage conditions.....	{	Elkton loam.
	{	Elkton silt loam.
Soils formed under swampy drainage conditions.....	{	Portsmouth sandy loam.
	{	Portsmouth loam.
Unclassified alluvium and semiswampy upland.....	{	Meadow.
Alluvium subjected to tidal overflow.....	{	Tidal marsh.

The local names of soils have been brought out in their proper relationship to the several types in so far as these names are sufficiently definite to admit proper correlation in this detailed soil classification.

The Sassafras soils are confined largely to the upland plain, although several members of the series occur in small areas in the lower foreland. The Portsmouth soils are confined almost entirely to the uplands, and principally in northern Caroline County and the bordering portion of Queen Anne County. The Elkton soils are found throughout both the low forelands and the upland country. The extent and location of the various types are shown on the accompanying map made on a scale of 1 inch to the mile. The general lay of the land is also shown on the map by contour lines drawn through points of equal elevation above sea level, and thus, besides showing the character, extent, and location of the several soils, the topographic relief of the entire country, the direction of natural drainage, and the proper location for artificial drainage ways are indicated.

The names of the several types, together with their actual and relative extent, are given in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Sassafras sandy loam.....	160,576	25.9	Sassafras fine sandy loam....	18,496	3.0
Sassafras silt loam.....	130,944	21.2	Tidal marsh.....	15,616	2.5
Sassafras loam.....	101,760	16.4	Elkton sandy loam.....	9,280	1.5
Sassafras loamy sand.....	52,992	8.6	Portsmouth loam.....	2,944	.5
Elkton silt loam.....	42,432	6.9	Sassafras gravelly loam.....	2,880	.5
Sassafras sand.....	29,696	4.8	Elkton loam.....	2,624	.4
Portsmouth sandy loam.....	27,840	4.5			
Meadow.....	20,496	3.3	Total.....	618,560	.....

SASSAFRAS SAND.

The surface soil of the Sassafras sand to a depth of 5 to 10 inches is a dull-brown sand, with a predominance of the coarse and medium grades. The subsoil is a reddish-yellow, sometimes an orange-yellow, sand which generally becomes slightly loamy and coarser toward the lower portion, frequently being underlain at about 32 inches by a reddish-yellow or reddish-brown sandy loam or sticky coarse sand. The underlying substratum is quite variable in its texture and profile features. Generally it consists of a succession of strata and seams of silty clay, coarse, medium, and fine, loose, or very compact sands or gravelly sands, and fine, medium, and coarse gravel, which vary in thickness from an inch to about 3 feet and in color from light and bluish gray to a deep reddish brown. Although in its mineralogical composition the soil material is mainly quartz, close examination reveals the presence of other minerals. Generally

the finer particles cling to the larger grains in a way that tends to impart more coherence between the constituents than in case of the loose, incoherent Norfolk sand which covers extensive areas in other parts of the Coastal Plain. The Sassafras sand has not been so thoroughly reworked and washed as the latter soil and, therefore, is not so clean a sand. However, the grains have suffered considerable abrasion and are more or less rounded.

In small areas quartz gravel is interspersed throughout the soil mass, but not in sufficient quantity to change the character of the soil materially.

The Sassafras sand occurs largely in comparatively narrow belts along the east side of the Choptank River and Tuckahoe and Marsh Hope creeks in Caroline County and the south side of the Chester River, approximately from the Chestertown bridge to the Delaware line. Isolated areas occur here and there in the uplands. There is a considerable area in northern Caroline County. Along the streams it varies from flat forelands nearly on a level with tidewater to a gently rolling topography on the slopes. The upland areas occur as ridges and knolls. In upper Caroline County the type is closely associated with the Sassafras loamy sand. Here the knolls and ridges rise gradually from the level of the flat Portsmouth soils to a height of about 15 feet. The water table lies quite near the surface. There are numerous pot holes or small, rounded depressions in which poor drainage has favored the development of small areas of Portsmouth soils, which owing to their inconsiderable size were included with Sassafras sand.

Wind action may have aided in the formation of these ridges and knolls by assorting and blowing the sand from surrounding areas which supported less vegetation probably during dry periods long before the present wet conditions had appeared. The original material of the type was transported by water from the region of crystalline rocks north of Maryland.

The forested areas support a growth of shortleaf pine with a sprinkling of oak near the boundaries of the heavier soils.

The Sassafras sand is a well-drained, warm, early soil, well adapted to vegetables, especially early market-garden varieties. Excellent tomatoes, asparagus, Irish and sweet potatoes, garden peas, turnips, melons, and cucumbers can be easily grown. The yields depend largely upon the organic-matter content. There are very few soils that respond more quickly to applications of barnyard manure and the turning under of green crops, particularly legumes, such as cow-peas and crimson clover. Incorporations of such vegetable manures should be made at frequent intervals and in considerable quantities, as the soil is so thoroughly aerated and well drained that the decomposition of organic matter takes place at a comparatively rapid rate.

Excellent crops of rye can be made after turning under cowpeas or crimson clover as green manures and applying moderate quantities of phosphate potash fertilizer. An application of about 35 bushels of air-slaked lime in conjunction with the turning under of heavy crops of vegetation, such as cowpeas or crimson clover, would materially assist in improving the structure of this soil by binding together the soil particles, so as to make it less open and porous. Although the type in its average condition of fertility gives rather moderate yields of the general farm crops, in years of normal rainfall very fair wheat and good corn returns can be obtained. Where the humus content has been kept up, as high as 20 bushels of wheat and 40 bushels of corn per acre have been made under conditions of fair soil treatment. Although the grasses do not do well, heavy crops of cowpeas, crimson clover, and sorghum can be made. This is a good soil for growing cowpeas for seed. Dewberries do well and strawberries fairly well. Cultivated chestnuts seem to find an especially favorable environment on this soil.

The soil is very easily tilled and can be kept in fair condition by applying barnyard manure and turning under green legumes once every two or three years. Crops are inclined to suffer from drought in dry seasons. This type of soil can be bought for less than the heavier soils, from \$20 to \$30 being a fair price.

The following table gives the average results of mechanical analyses of samples of the Sassafras sand:

Mechanical analyses of Sassafras sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17908, 17923, 17925.	Soil.....	2.5	35.9	30.5	22.8	1.0	3.9	3.3
17909, 17924, 17926.	Subsoil.....	2.2	35.8	30.7	23.3	.6	3.8	3.7

ELKTON SILT LOAM.

The soil of the Elkton silt loam is a very light-gray to almost white silt loam. In a field in good tilth it is loose and floury, the light color and fine texture being its most marked characteristics. It contains very little medium and practically no coarse sand. The percentage of fine sand is usually low, and there is only a moderate quantity of clay. The chief constituent is silt, which forms from 60 to 80 per cent of the soil body. When wet it is yielding under foot, in some instances quite miry, but not particularly adhesive. On drying it coheres in a firm mass which may have minute cavities interspersed through it.

The organic matter content appears to be low. In the virgin soil of the woodland there is usually 2 or 3 inches of darker colored soil slightly stained by humus, but immediately below this the material is white and powdery.

In most places there is no well-defined line of contact between the soil and subsoil. The latter has about the same texture to a depth of 12 or 15 inches, below which there is an increase in the clay content. This difference in composition is most apparent between the depths of 18 and 30 inches. It is usually observable in an exposed section and is very apparent on digging or boring into the subsoil. The subsoil forms a compact stratum, very hard when dry, and, when wet, somewhat more sticky or plastic than the soil.

The subsoil at a depth of about 3 or 4 feet frequently changes to a grayish sand, medium to coarse in texture and usually saturated. This stratum varies from 1 to 2 feet in thickness and is usually underlain by a heavy bed of clay. Frequently the sandy stratum has a thin layer of soft, white, unctuous clay in it. This stratum seems to be nearly or quite impervious and is probably the cause of the saturated condition of the overlying sand.

The subsoil proper is of a grayish color somewhat darker than that of the soil. It is generally mottled with yellow and brown iron stains, especially if pockets or seams of sandy material are present. The heaviest part of the subsoil is usually a bluish-gray color with very little mottling.

This soil attains its typical development in the western part of Talbot County. The largest areas are found in the peninsulas lying between the estuaries. The central portions of most of these necks are nearly level, and the sluggish surface drainage, together with the character of the material, accounts for the formation of this type. Smaller areas are found in the uplands wherever similar conditions prevail.

The type is associated with the Sassafras silt loam and is derived from the same kind of material. The differentiation is due entirely to drainage conditions. While the two soils are very distinct in color, organic matter content, and general agricultural value, the change from one to the other is frequently so gradual that it is difficult to draw an exact boundary.

The original vegetation consisted chiefly of white oak, and the land is now locally termed "white oak land." A mixed forest now occupies uncleared fields, and loblolly pine, which came in when the original white oaks were removed, is a common species and attains good size. Other kinds of oak trees, with gum, soft maple, beech, and dogwood, are very commonly found on this type.

Much of this soil is under cultivation. It is somewhat difficult to manage, especially in wet seasons. After a rain the soil tends to run together, and on drying forms a smooth, hard surface. When slightly moist it yields very readily to tillage.

The Elkton silt loam is well adapted to timothy and excellent crops are grown. The acreage planted to this crop is rather limited, and could be increased with profit. Red clover does not grow on this soil well, probably on account of a somewhat acid condition. In fields which have reasonably good surface drainage scarlet clover is successfully grown. A large proportion of the tillable area of this type is annually sown to wheat. The same cultural methods are generally practiced as on the Sassafras silt loam. In seasons which are not excessively wet the average yields compare well with those of the Sassafras soil. In some seasons a good crop of corn is secured, but this land is too cold, wet, and deficient in humus to be well adapted to this cereal.

The improvement of many of the small areas in the highland country requires ditches of sufficient capacity to remove promptly the excess water. Ditches should be located near the upper margin, so that the water will be intercepted and not saturate the lower lying soil, as is the case where the main ditch is placed near the center of the area. It is highly essential that the ditches be deep enough to lower the water table to $2\frac{1}{2}$ or 3 feet below the surface, so that the subsoil may be aerated.

The permanent improvement of the larger areas, particularly those on the "necks," is a more difficult problem. They are larger and so flat that it is sometimes expensive to construct ditches with an adequate outlet.

The nature of the strata underlying the subsoil has already been briefly described. It seems probable that the structure of the deeper subsoil is the same for much of the Elkton soil of the "necks" and for the Sassafras silt loam adjoining these areas. The roadside cuts on the slopes leading down from the upland often show a light-colored clay with sandy material between the subsoil and the deeper subsoil. Any excess of water in the soil of the higher ground tends to follow the sandy stratum to the lower levels. Where no natural drainage line intervenes between the higher ground and that somewhat lower a positive upward pressure of the ground water may exist in the latter. This is probably why the subsoil of the Elkton silt loam remains saturated long after surface conditions would indicate a normal moisture content.

The present artificial drainage consists of surface ditches. They are usually shallow—only a foot or two in depth. These serve to remove the excess of rainfall, but fail effectually to drain or prevent

a waterlogged condition of the subsoil. It is highly desirable that the lower soil be so drained as to have comparatively free access of air.

It can not be positively stated, however, that even thorough drainage alone will result in an immediate improvement of this soil. It has been so long subject to intermittent saturation that its constituents have undergone important changes. The soil has quite lost the property of granulation as is evidenced in its lifeless, puttylike feel when moist and its firm cementation when dry.

The frequent unsatisfactory crop yields from well-drained land which has been given good culture indicates a poor structural condition or the presence of injurious substances. There are very few iron concretions. The ferruginous material is seldom further concentrated than in small, soft grains and thin streaks of limonite, or other compounds of iron, and these are not abundant in the heaviest phases of this soil where aeration is least active. It is probable that the decaying organic matter under the moisture condition which usually prevails renders soluble much of the iron forming ferrous carbonate, a substance injurious to cultivated plants. Under similar conditions the phosphoric acid of the soil combines with the iron in an insoluble form, thereby becoming unavailable for crops.

Experience has shown that a heavy application of coarse manure often gives surprisingly good results. There should be an abundance of organic matter incorporated with the soil, which can be most cheaply done by plowing under some green crop. This should be done in early fall or precede by some months the time of planting the next crop, so that partial decay may take place. Otherwise more harm than good may be done the first crop. Complaint is made sometimes that saturating rains following deep fall plowing cause the soil to run together in such a way as to give rise to the formation of an almost glasslike smooth surface, which bakes and hardens with subsequent sunshiny weather. This trouble would be lessened by the incorporation of coarse manures, the application of lime, and general improvement of the drainage condition.

Lime should be liberally applied (30 to 40 bushels an acre), not only for the favorable chemical effect it has on this soil, but that flocculation of the clay may be favored. Turning under green vegetation should be done always in conjunction with an application of from 25 to 50 bushels of lime per acre.

After the physical condition of the soil has been improved in the manner thus outlined, its further fertilizer requirements depend upon the crop to be grown or the method of farming practiced. It will probably be found that little or only moderate amounts of commercial fertilizer are needed. In case fertilizer is found to be necessary, one containing a high percentage of phosphoric acid would be of benefit, especially to wheat.

Where it is impracticable to drain land of this kind it seems that such crops as timothy and redtop offer the best means of utilization.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Elkton silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16990, 17900.....	Soil.....	0.2	2.3	2.5	4.8	2.6	77.5	10.0
16991, 17901.....	Subsoil.....	.2	3.2	3.2	5.1	2.9	63.7	23.0

A determination of the organic matter gave the following percentages: No. 16990, 3.55 per cent; No. 17900, 1.42 per cent.

SASSAFRAS SILT LOAM.

The Sassafras silt loam to a depth of 8 or 10 inches is a friable silt loam. A dry sample rubbed between the fingers breaks into a soft, pulverulent mass in which little or no medium sand can be detected. A perceptible quantity of fine sand is present, consisting in part of minute mica flakes. When wet such a sample is somewhat plastic, mulches easily, and shows little tendency to adhere. On drying it becomes crumbly, the fragments being weak and porous.

The soil yields readily to tillage, and the cultivated land has a soft, loamy surface. A considerable portion of the first 2 or 3 inches will be almost pulverulent if the field has been harrowed or rolled when in a slightly moist condition. If clods form at all, they are generally small, porous, and break under a light pressure.

The color of the moist soil is usually a yellow brown. It becomes lighter as the moisture content decreases and not infrequently approaches a buff or very light yellowish brown. An exposed section in a roadside cut generally shows, beneath an inch or two of grayish surface loam, a light-yellowish soil grading downward to a reddish yellow or dull reddish brown, which is usually the color of the subsoil.

The subsoil contains more clay than the soil and is usually rather compact. Between the depth of 15 and 30 inches it is somewhat granular. On drying it breaks into roughly angular fragments. The granulation is not strongly developed and is easily destroyed by manipulation when the material is moist.

This soil is found in the southeastern and southern parts of Queen Anne County and is of common occurrence throughout Talbot County. A few small areas occur in Caroline County. It ranges in altitude from 10 to 70 feet above sea level and attains its typical development on the gently undulating interstream divides. On the "necks" this type is confined to those portions which have rela-

tively good drainage. Where the surface has little or no relief the Sassafras silt loam gradually passes into the Elkton silt loam. Wherever the surface is more rolling some of the lighter soils are generally found.

The drainage is usually good. The sandy substratum gives excellent underdrainage and prevents any undue accumulation of water where the surface is slightly depressed.

The color of the subsoil is a reliable indication of the average moisture conditions. Where the color is brown or approaches a reddish yellow the drainage is effective and the soil mass has good aeration. Where the drainage is not as thorough as it should be or is somewhat sluggish the soil usually is of a pale-yellow shade.

In some of the depressions which occur in this type the soils have a texture, structure, and color so different from that of the Sassafras series that they belong to the Elkton series. The areas are usually too small or ill defined to be shown on a map of the scale used.

All of this type was originally forested. It seems to be a congenial soil for numerous species of trees and shrubs. Most of it is now under cultivation, but in the forested portions almost every variety of tree common to this section of country may be found, excepting those confined to marshy soils.

The Sassafras silt loam is well adapted to grass, forage crops, and wheat. The average yields of grain are quite as high as upon any other type in the area. Its texture admits of the preparation of an ideal seed bed, and the average moisture content is favorable for winter wheat. Its structure admits of only a minimum loss through leaching of the fertilizer applied. Twenty-five to 30 bushels of wheat per acre is not an uncommon yield in favorable seasons, but the average is nearer 18 or 20 bushels.

Clover and timothy do well. It is sometimes difficult to secure a good stand of clover, but this trouble is due to cultural practices or seasonal extremes rather than any condition peculiar to the type.

The yields of corn in favorable seasons average from 50 to 60 bushels per acre. The yield could be improved by liberal applications of organic matter. The usual supply of barnyard manure and the frequent changes to grass fail to give the needed quantity of humus. The fact is frequently overlooked that a high organic matter content, besides assisting in the maintenance of moisture, also improves the physical condition of the soil. In this instance it would tend to prevent the "running together" of the surface soil after each heavy rain.

This is the heaviest well-drained soil in the area. It should be restricted to those crops which require a long growing season and for which a continuous moisture supply is of first importance.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Sassafras silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16988, 17011, 17939.	Soil.....	0.6	2.8	2.7	4.3	8.9	71.9	8.6
16989, 17012, 17940.	Subsoil.....	Tr.	1.1	1.5	2.9	9.7	65.1	19.4
17013.....	Lower sub-soil.	3.6	18.3	12.4	8.3	0.5	45.8	11.6

A determination of the organic matter gave the following percentages: No. 16988, 1.02 per cent; No. 17011, 1.07 per cent; No. 17939, 0.92 per cent.

SASSAFRAS LOAMY SAND.

The Sassafras loamy sand represents a transition between the sand and sandy loam of the Sassafras series. In agricultural value it is much inferior to the normal sandy loam of the series, but is much more productive than the sand. It presents variations which are apparent even upon casual examination, and which are of considerable importance from an agricultural standpoint. These are determined for the most part by the distribution, or location, in the soil profile of the silt and clay.

In the greater proportion of this soil the fine material is found largely between the depths of 15 and 30 inches. The most extensive development of this phase occurs on the east side of the Choptank River, extending as a fairly continuous belt between the sand which borders the river and the heavier soils of the uplands. There are also considerable areas in the southeastern part of Caroline County which have a similar relation to the streams of that section.

The soil to a depth of 6 to 8 inches is a dull-brown loamy sand. All grades of sand are found, but medium to coarse grains usually form a considerable part of the whole and give a coarse, gritty character to the material. There is some small quartz gravel, which with the larger sand grains is quite conspicuous on the surface after a rain. The proportion of fine material is usually sufficient to cause the sand to cohere feebly if a moist sample is pressed in the hand. When dry it is quite loose, but not so incoherent as the Sassafras sand.

The upper part of the subsoil has about the same texture and structure as the soil. It is much lighter in color, usually a pale yellow. At a depth of 15 inches there is a perceptible increase in the percentage of fine material. This lower part of the subsoil is a moderately heavy sandy loam. If moist it is somewhat sticky; when dry the fine material binds the sand grains in a rather friable mass. Unless excep-

tionally coarse it possesses good capillarity. This part of the soil section is essentially the moisture reservoir of the soil.

The surface of most of this phase is gently undulating. Some areas of considerable size are nearly level or have a low but very uniform slope toward the nearest stream. Slight inequalities of the surface frequently indicate differences in the agricultural value of the land, the high ground usually having the heavier subsoil. Not infrequently small elevations are much lighter in texture, but in general this type passes into the Sassafras sandy loam along the higher contour lines.

In some places the surface assumes a grayish tint when dry, while the subsoil approaches pale yellow in color. This indicates poor drainage. This condition is not always due to topographic position, for some of this phase is underlain by a thin clay stratum similar to that found under the Elkton silt loam. It frequently occurs at a depth of 40 or 50 inches, but seems to be local in its development. Some of the light land east of the Choptank River between the towns of Fowling Creek and Bethlehem has such a structure of the deep subsoil and crops frequently suffer during prolonged wet periods.

Where drainage is necessary the proper location of ditches is somewhat difficult to determine. The depth to the clay substratum and the direction of its slope should be taken into consideration. In most instances the ditch should be dug along the upper side of the tract to be drained instead of being located in the middle or lower part.

The native timber growth comprises most of the oaks common to this area and sweet gum, dogwood, and pine, with a few birch, beech, and hickory. Alder and huckleberry are abundant undergrowths. Crabgrass commonly takes possession of neglected fields, followed later by loblolly pine.

In another phase of this type the silt, clay, and various grades of sand are evenly distributed throughout the upper 30 inches of the soil section, there being very little difference between the soil and the subsoil. This variation is found in the northern part of Caroline County. The topography of most of it may be described as "hummocky." The surface consists of low mounds and very irregular ridges, seldom rising more than 10 or 15 feet above the intervening depressions. The latter vary from spots a few rods across to ill-defined, semimarshy areas containing many acres.

The Sassafras loamy sand occurs on the higher ground, while the Portsmouth sandy loam is found on the low land. The subsoil of many of the narrow or moundlike ridges is very light, but usually has enough silt and clay to cause a slight crust to form after a rain. In most fields small, friable clods form if the land is plowed when wet. The organic matter content is low.

Between the depths of 15 and 25 inches the subsoil is frequently very compact when dry. It seems to be due to a filling of the interstices with fine material rather than cementation or coherency of the clay content. The deep subsoil consists of loose, coarse sand. It does not generally afford good capillarity between the water table below and the subsoil, although the former stands within 10 or 15 feet of the surface.

The oak trees on this phase of the Sassafras loamy sand do not generally attain a large size. A variety of pine having a short bristly leaf is common, and in places forms much of the timber growth.

Some of the Sassafras loamy sand in the neighborhood of Preston and Federalsburg is a light soil of good quality to a depth of 12 or 15 inches, resembling the sandy loam. The subsoil is a medium to coarse sand, or occasionally a very light sandy loam. This phase is of limited extent and often occurs near larger areas of the Sassafras sandy loam.

This soil is easily cultivated and responds well to fertilization. Since all of it is very deficient in humus, the organic matter content should be increased. It would also be of benefit to have some cover crop during the winter. This prevents to some extent the excessive leaching to which these light soils are subject. An acreage application of about 30 bushels of lime in conjunction with a green crop, preferably cowpeas or clover, would improve the structure; that is, bind the soil particles into such an arrangement as would make the soil less open and droughty.

Much of this soil is now used for general farm crops. The yields of corn and wheat are low and often severely affected by dry weather. It is better adapted to truck crops and an increasing acreage is being planted. Melons, cantaloupes, tomatoes, and sweet potatoes are successfully grown. Buckwheat, crimson or scarlet clover, and cowpeas do well and many small fields of the crops are grown. Peach orchards might well be located on the well-drained portions of the soil.

The market value of all the areas of this soil is steadily advancing. The price per acre ranges from \$5 or \$10 to \$25. Small tracts well located with regard to shipping points or near a cannery command a much higher price than those not so favorably situated. More of the Sassafras loamy sand can be utilized profitably in the production of early vegetables and tomatoes.

The following table gives the average results of mechanical analyses of the Sassafras loamy sand:

Mechanical analyses of Sassafras loamy sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
17048, 17902.....	Soil.....	1.6	20.5	22.4	28.2	1.7	18.3	5.9
17049, 17903.....	Subsoil.....	1.5	22.3	21.8	30.2	2.6	15.3	5.7

SASSAFRAS SANDY LOAM.

The Sassafras sandy loam in its typical development to a depth from 9 to 13 inches is a grayish-brown or brown moderately heavy sandy loam, consisting of a fairly even distribution of the coarse, medium, and fine grades of sand with a relatively high proportion of silt which coheres to the sand grains so as to impart a distinctly loamy character to the soil, especially when dry. The soil always has a more pronounced sandy feel when wet, owing to a weakening of the binding power of the finer material which is given freer movement by the excess of moisture. There are some areas very much lighter than the general average as described above. The absence of very fine sand is everywhere noticeable. The subsoil consists of a reddish-yellow or reddish-brown sandy loam or heavy sandy loam which at 26 to 30 inches generally passes into a reddish-brown coarse light sandy loam to sticky coarse sand, with small quartz gravel sometimes quite compact. The tendency is toward a slightly lighter and coarser textured subsoil, more compact and more nearly red with increasing depth. Sometimes the upper portion of the subsoil is pale yellow and siltier than the average, while in the more nearly level and poorer drained areas the pale yellow may extend as far downward as the change in the substratum. As a rule the subsoil is only slightly heavier than the surface soil, and like it carries considerable silt and little very fine sand. Generally the well-drained soil becomes lighter in color as the organic-matter content diminishes, but fields often are spotted with gray in slight depressions, where the soil approaches the Elkton sandy loam, and may contain considerably more organic matter than the surrounding better drained and more productive soil. The better drained brown phase of the northern part of the area tends to give way to a lighter colored and somewhat less productive phase accompanying a moderation in the surface relief toward the south. Occasionally small areas are quite gravelly, especially on stream slopes. A more nearly red subsoil is found in the better drained areas. The type is locally styled "red clay bottom" or "medium light loam."

On account of the coarser substratum excellent underdrainage obtains throughout the larger proportion of the type, which feature, coupled with the good texture of the overlying material, makes the type a thoroughly aerated soil, capable of maintaining a supply of moisture favorable to healthy plant development.

Under fair treatment the soil is tilled easily under widely different moisture conditions, yielding most readily to treatment of all the extensive general purpose soils. However, continuous cultivation without restoring vegetable matter, especially where closely grazed through all sorts of weather, is apt to induce a compact structure resistant to plowing and favorable to excessive loss of moisture in dry spells by surface evaporation.

The Sassafras sandy loam occurs throughout the survey and is largely confined to the uplands. It is conspicuously absent from the lower forelands. It sometimes follows the slopes of the inland stream valleys nearly to tide level, thus occupying all variations in land surface from broken stream slopes to moderately rolling and nearly flat upland country. In some sections the surface configuration is interrupted by small poorly drained depressions, some of which contain bodies of Portsmouth or Elkton soils too small to be outlined on the map.

The type has been derived from sediments of marine deposition brought down from the region of crystalline rocks to the north of Maryland and Delaware. The sand particles are generally less round than those of the Sassafras sand, showing that the material has been subjected in a less degree to reworking by water and wind. Since the elevation of the sedimentary material above the sea considerable weathering has taken place to a depth of 3 feet or more. This weathering mainly consists in the oxidation and consequent change in color of the material and the accumulation of organic matter in the surface. There has been considerably less washing out of the fine materials and leaching than in the Norfolk sandy loam, a much less productive soil occurring extensively in other parts of the Coastal Plain.

The Sassafras sandy loam is adapted to a wider range of crops than any other type of the area. The principal crops are corn, wheat, tomatoes, and grass. Under favorable conditions of weather and soil management, and accordingly as the crop is grown on the lighter or the heavier phase, wheat yields from 15 to 30 bushels, corn from 35 to 65 bushels, hay from 1 to 2 tons, and tomatoes from 4 to 12 tons per acre.

This is the best tomato and strawberry soil of the area. Excellent returns were secured from a large acreage of tomatoes put out in 1907, averaging 5 tons per acre, and a considerable acreage of strawberries was also very profitable in the neighborhood of Ridgely.

Irish potatoes, sweet potatoes, cantaloupes, watermelons, cucumbers, and asparagus do well, as do all kinds of forage crops suited to this climate. Pears, peaches, chestnuts, dewberries, raspberries, and blackberries find the soil well suited to their needs. In view of the ease with which good crops of cowpeas and crimson clover can be secured, and the readiness with which the soil responds to applications of barnyard manure, these legumes should be more generally grown in connection with an extension of the live-stock industry. Some claim that the soil is not well enough adapted to grass to yield satisfactory returns in stock raising, but by growing forage crops, excellent yields of which can be obtained, any such deficiency can be offset. A ton or two per acre of hay, however, is not considered poor even in the most prosperous stock raising sections.

Turning under green crops of cowpeas or clover grown in rotation with wheat, corn, tomatoes, or grass, or any other rotation, in conjunction with applications of 25 to 40 bushels of lime per acre every four or five years, is the most economical method of improving and maintaining the productivity of the type. Two excellent rotations are corn with cowpeas or crimson clover, wheat, grass, wheat, cowpeas, or clover to be turned under and limed, then corn; and corn, with cowpeas or crimson clover, tomatoes, wheat, grass and clover, corn. The same fertilizers are used upon this soil as upon the other soils of the area.

The type sells for \$25 to \$60 an acre according to location and improvements.

The following table gives the average results of mechanical analyses of the soil and subsoil and the results of a single determination of the lower subsoil of the Sassafras sandy loam:

Mechanical analyses of Sassafras sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17014, 17917...	Soil.....	2.9	20.9	15.4	17.7	2.7	35.2	5.1
17015, 17918...	Subsoil.....	2.9	18.5	11.9	14.1	3.0	35.7	13.9
17919.....	Lower subsoil..	1.3	19.2	19.3	26.1	3.9	17.5	12.2

A determination of the organic matter gave the following percentage: No. 17917, 1.05 per cent.

SASSAFRAS FINE SANDY LOAM.

The surface soil of the Sassafras fine sandy loam is a grayish-brown to yellowish-brown quite silty fine sandy loam which grades into a pale-yellow material of the same texture a few inches beneath the surface. At about 20 inches the soil portion is underlain by a reddish-yellow, compact, rather clammy light silty loam, which in turn is underlain at 28 to 36 inches by an orange-yellow, reddish-yellow or

reddish-brown, light, fine to medium sandy loam. Wherever the relief is sufficient to insure good drainage the subsoil is quite friable, admitting of good aeration and circulation of moisture. On the other hand, the subsoil of the flat bodies lying in swales or near the water level is inclined to be mottled in color, clammy, and insufficiently aerated on account of poor drainage. The productiveness of the Sassafras fine sandy loam depends largely upon the drainage.

The type is confined largely to the necks and water fronts lying below the 25-foot contour line. The most important areas are those on Piney Neck, on Kent Island, in the Stevensville neighborhood, the extensive area including the greater part of the neck south of Claiborne, and the upland strip occurring along the 50-foot contour line or rim of the highland bordering the Choptank River valley from a point just south of Trappe to the neighborhood of Manadier. The topography of this higher area is moderately rolling. Its drainage is very good. The lower foreland is about equally divided between that having an undulating to slightly ridgy surface with good natural drainage and that having a nearly flat surface with poor underdrainage.

The type is fairly easy to cultivate, especially where the drainage is good, although in dry weather the soil is inclined to bake and harden in a way that makes fall breaking quite difficult, requiring considerable harrowing and rolling to bring it into a good tilth.

About 50 per cent of the Sassafras fine sandy loam is under cultivation, the remainder being forested mainly with pine, white oak, chestnut, sweet gum, black gum, and dogwood. It is devoted to general farming, including the production of wheat, corn, grass, and tomatoes. The yields of corn and wheat are about the same as on the Sassafras sandy loam, but the yields of timothy are thought to be better. Although the type does not have the texture of a typical truck soil, very fair yields of tomatoes of good quality are grown. Alfalfa seeded in the fall would do well on the better drained phase. Like the Sassafras loam, it requires regular applications of vegetable manure, barnyard manure, or legumes turned under in order to maintain favorable structural conditions.

The poorer drained areas are so situated that very effective drainage systems could be installed with inconsiderable outlay. Good results could be had with deep open ditches through the lower depressions; but much more satisfactory results would be obtained by installing lateral tile drains to discharge into main open ditches.

The Sassafras fine sandy loam can be bought for about \$25 to \$50 an acre.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of this type:

Mechanical analyses of Sassafras fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17927.....	Soil.....	0.1	2.0	14.3	29.2	10.1	35.6	8.7
17928.....	Subsoil.....	.2	1.6	12.8	28.0	8.0	25.9	13.8
17929.....	Lower subsoil..	.0	1.4	20.0	41.6	10.0	15.2	12.1

SASSAFRAS LOAM.

The surface soil of the Sassafras loam consists of a brown or yellowish-brown moderately heavy loam from 8 to 16 inches deep. The typical subsoil is a reddish-yellow heavy loam carrying about the same amount of silt but a little more clay than the soil. It becomes reddish brown in the lower portion, passing at 26 to 32 inches into a reddish-brown coarse sandy loam to sticky coarse sand with fine quartz gravel. Often the subsoil is pale yellow or yellow in the upper part of the profile, but always tends toward a reddish color with increase in depth. As a general thing the better the drainage the more nearly reddish brown becomes the subsoil. The type is locally called "red clay" or "medium stiff loam."

Not infrequently small quartz gravel is distributed throughout the soil mass, but never in sufficient quantity to influence materially the moisture-holding capacity. Minute flakes of mica can be seen distinctly in the subsoil in some places, though not so generally as to be a distinguishing feature.

Although the texture of the Sassafras loam is quite uniform, it requires close observation to determine the exact boundary between its lightest phase and the heavier Sassafras sandy loam, while on the other hand the gradation into the lighter phase of the Sassafras silt loam is very insensible.

Both soil and subsoil have an ideally well-balanced texture; that is, the constituent particles of sand, silt, and clay are so proportioned and arranged as to constitute a soil capable of maintaining moisture in the most favorable quantity for the healthy growth of plants. However, where the organic content has been allowed to run down through continuous cropping without replenishment of vegetable matter, and where the land has stood long without cultivation—especially if cattle have been permitted to graze it closely and pack it during all kinds of weather—the soil assumes a hardened, compact structure unfavorable to cultivation, especially in dry falls. Such fields break up in clods and repeated rolling and harrowing are required to restore a good

tilth. If the supply of humus is kept up and due attention is paid to moisture conditions in their relation to plowing and grazing, the soil can be kept in the best condition of tilth.

The Sassafras loam is confined largely to the uplands of Queen Anne, Talbot, and eastern Caroline counties, and is rarely found east of the Choptank River. A small percentage occurs in the lower foreland country, and it is even found along the steeper slopes. Its topography is quite like that of the Sassafras sandy loam, though generally somewhat less rolling. Where the relief has favored erosion the surface soil has been removed from small spots, revealing the yellowish-red subsoil in such a way as to give fields a spotted appearance. These spots, owing to the higher content of clay, are a little more difficult to cultivate than the true surface soil. They are sometimes called "clay hills."

While the texture affords good natural drainage, an occasional flat or depressed area will need main outlet ditches and tiling.

The Sassafras loam owes its origin to the weathering of marine deposits under good drainage conditions. It has since its uplift undergone about the same degree of weathering as the Sassafras sandy loam.

This is the best general farming soil of the area, being ideally adapted to wheat, corn, grass, clover, and forage crops and quite well suited to certain truck crops like tomatoes, beans, and cabbage. Wheat yields from 18 to 35 bushels, corn 40 to 75 bushels, and grass 1 ton to 2½ tons per acre. Where the soil is kept up to a good state of productiveness, as under a five-year rotation of corn, wheat, grass, wheat, grass, applying barnyard manure and 40 bushels of lime to the broken grass sod preceding corn and about 300 pounds of good commercial fertilizer to wheat, average yields of 60 bushels of corn, 20 bushels of wheat after corn and 28 bushels after grass, and 1½ tons of hay per acre are readily secured. If occasional crops of cowpeas or clover, to be turned under in conjunction with 40 bushels of lime per acre, should be introduced into the above general scheme of rotation, the most worn fields of the type could be brought quickly up to a point of equal productiveness or even better. Alfalfa does well when seeded properly; that is, in the fall, on a thoroughly prepared seed bed.

A large acreage of tomatoes is grown on this type, the average yield being about 4 tons per acre. Strawberries, cantaloupes, asparagus, beans, and buckwheat do well. Peaches, pears, and raspberries grow rapidly and bear well. In view of the good yields of hay and forage crops stock raising should be extended. Dairying and sheep raising could also be made quite profitable. There is no excuse for other than good average yields on the Sassafras loam, as it is easily

improved and kept in good condition. Its valuation varies greatly with location. Generally outside the influence of towns it can be bought anywhere from about \$40 to \$65 an acre, though in some of the poorer drained localities it can be had for less.

The following table gives the average results of mechanical analyses of samples of the Sassafras loam:

Mechanical analyses of Sassafras loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17003, 17933 ..	Soil.....	2.3	13.7	9.9	12.7	3.2	50.1	8.4
17004, 17934 ..	Subsoil.....	1.3	10.0	9.5	13.9	4.3	46.1	14.3
17005, 17935 ..	Lower subsoil ..	5.2	25.2	17.4	21.8	3.1	14.1	12.5

SASSAFRAS GRAVELLY LOAM.

The Sassafras gravelly loam consists of a loamy soil resembling the Sassafras loam, through which from 10 to 25 per cent of small and medium rounded quartz gravel is distributed.

The type occurs as narrow strips along stream slopes or as small patches on upland slopes. It owes its origin largely to a partial removal of the soil mass by wash, so as to expose the more gravelly material beneath.

There are throughout the area surveyed quite a number of these gravelly spots of limited extent and irregular occurrence. Only the larger areas are shown. The type is most frequently seen in the northwestern part of Queen Anne County. It is suited to the same crops as the Sassafras loam and where not too sloping for easy cultivation it makes profitable yields.

ELKTON SANDY LOAM.

The surface soil of the Elkton sandy loam consists of 6 to 10 inches of dark-gray, clammy, rather silty sandy loam which becomes light gray in the lower portion. The subsoil is a clammy, medium heavy sandy loam to loam carrying considerable silt. The upper portion is a light-gray to drab, frequently slightly mottled with reddish-yellow streaks, while the lower portion is generally intensely mottled with grayish, reddish-yellow, and reddish-brown colors. Strata of clayey material are quite common in the lower portion, and at a depth of about 30 inches occurs a substratum of compact, light-gray or mottled, sticky, medium to coarse sand which is always saturated with water.

The type occurs as small bodies in depressions and as low, flat land around the heads of small streams. The drainage is very poor, the

water table generally standing very near the surface. The surface configuration of those areas found near the heads of streams is usually interrupted by small saucerlike depressions holding dark-colored material high in organic matter and generally in a semimarshy condition. The greater part of the type occurs as widely separated areas throughout the uplands of Caroline County, closely associated with the light Sassafras soils. There are small bodies throughout the uplands of the area, many of which are so small as to necessitate their being included with other types.

The Elkton sandy loam is derived from the same material that gives rise to the Sassafras sandy loam. The original material, subjected to intermittent wet and dry stages, has undergone unfavorable structural and probably chemical changes and has accumulated a small amount of organic matter in an apparently stagnant, unhealthy condition.

Most of the Elkton sandy loam is forested with sweet gum, white oak, maple, black gum, dogwood, scattered pine, and a thick undergrowth of shrubbery. Under present conditions of drainage it is hard to manage and comparatively unproductive. Buckwheat, strawberries, and dewberries do fairly well where the drainage is best. By deepening, strengthening, and extending the natural drainageways and by putting in close lateral tiles or even open ditches, most of the type could be brought into pretty good condition without a prohibitive outlay of money. Many of the small depressions can be drained simply by a deep outlet ditch. Wheat, strawberries, dewberries, and grass would do quite well. Coarse barnyard manure plowed under improves the aeration considerably, under fair conditions of drainage. The type is not as desirable a soil as the Portsmouth sandy loam.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Elkton sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17892, 17894.....	Soil.....	1.7	14.9	14.2	26.1	5.0	31.8	6.3
17893, 17895.....	Subsoil.....	1.4	12.8	12.8	29.2	5.3	25.2	13.1

A determination of the organic matter gave the following percentage: No. 17892, 1.56 per cent.

ELKTON LOAM.

In color and profile the Elkton loam is very similar to the Elkton sandy loam. The surface soil from 6 to 10 inches consists of a dark-gray, silty, medium loam which becomes light gray in the lower por-

tion. The subsoil to a depth of about 30 inches is a light-gray to drab, clammy, silty, heavy loam with a slight mottling of reddish yellow in the upper portion and intense mottling in the lower portion. Thin strata of clayey material occur in the lower profile. Below 30 inches there is usually found a substratum of light-gray, compact, medium to coarse sand always saturated with water.

The Elkton loam, like the Elkton sandy loam, occurs as poorly drained depressions and flat land around the heads of small streams. Narrow strips of Elkton silt loam are frequently found near the stream, while toward the outer edges, where the surrounding soil is light, may be found a narrow belt of Elkton sandy loam. Again, there may be small depressions holding darker colored soggy soils. These nonconformities, however, are not of sufficient extent to warrant their separation. The type is confined largely to Caroline County, occurring as widely separated bodies, the largest being those in the southeastern part of the county.

There is a phase of the type occurring in small, nearly flat bodies on the neck of land to the south of Claiborne, and in such places the soil to an average depth of 10 inches is a light-gray to ashy-gray, quite silty, very fine sandy loam.

About 75 per cent of the type is timbered mainly with white oak, maple, and gum. In its crop adaptation it is quite like the Elkton sandy loam, producing, however, better grass and wheat, but not as good corn, strawberries, and dewberries. It is probable that red-top, clover, herd's-grass and millet would do well on this soil. The type under present conditions of drainage is too soggy and cold to constitute even a fair agricultural soil. By draining the soil proper could be deepened and the subsoil opened, increasing the circulation of air and extending the zone for root development. Turning under partially rotted, coarse manure in conjunction with about 50 bushels of lime to the acre would go far toward rectifying the condition of the soil, though little permanent benefit can be expected until the soil is thoroughly drained. For this purpose deep open ditches and tiling are recommended.

The following table gives the results of mechanical analyses of a sample of the soil and of the subsoil of the Elkton loam:

Mechanical analyses of Elkton loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17896.....	Soil.....	2.0	12.7	11.0	16.5	3.0	48.9	6.4
17897.....	Subsoil.....	.9	10.4	10.0	15.1	3.1	49.7	10.0

PORTSMOUTH SANDY LOAM.

The Portsmouth sandy loam is a very dark-gray to black medium sandy loam of high organic-matter content, varying in depth from 8 to 12 inches. The subsoil to about 28 inches is a gray sandy loam with a slightly higher silt and clay content and much lower organic-matter content than the soil. The subsoil frequently is mottled with reddish yellow and in the lower portion may carry strata and pockets of sandy clay. It usually passes into a light-gray or nearly white, compact, coarse sand to sticky sand, which also may contain pockets and thin strata of sandy clay. This sandy substratum is always saturated, except where thoroughly drained. It is sometimes washed out into open ditches, filling the bottoms and causing the banks to cave. In some places the soil may consist largely of organic matter mixed with just enough earthy material to give it the characteristics of muck. Again, small areas may consist, from a few inches to a foot or more, of bog iron ore, occurring on top or at any position in the profile.

Uncleared areas support a growth of sweet gum, black gum, beech, maple, and scattering pine, with a dense undergrowth of whortleberry, gallberry, and other bushes.

The Portsmouth sandy loam is confined to northern Caroline County and the near-by contiguous portion of Queen Anne. It occupies level areas and small, basinlike depressions. The extensive flat areas are interrupted by ridges and knolls of the lighter Sassafras soils. In these lighter types occur numerous small depressed bodies, many of which were of too limited extent to indicate on the map.

The soil is almost entirely lacking in natural drainage. All of it, however, can be reclaimed. While some substantial, effective ditches were put in years ago and some are still being dug in a few places, thus reclaiming considerable areas, the work has not been pushed persistently, and at present the type on the whole is too poorly drained to admit of profitable cultivation. Ditches too frequently have been allowed to fill. Some of the farmers, by keeping the main ditches cleaned out and extending laterals, have reclaimed limited tracts. Individual effort can not cope successfully with the problem in the larger bodies. There must be substantial main ditches, the construction of which is feasible only through the concerted action of land-owners, assisted possibly by the county or the State, and by drainage laws opening the way for outlets.

The type is derived from the same material that gives rise to the Sassafras and Elkton sandy loams. The topography has induced wet, swampy conditions which have favored accumulation and preservation of a large quantity of spongy vegetable matter in the soil, at the same time retarding subsoil weathering.

When thoroughly drained the Portsmouth sandy loam proves a very productive soil. Excellent yields of strawberries, corn, and

dewberries are made. Owing to a tendency of the soil upon freezing to heave, the type is not especially suited to fall-sown crops. Wheat and grass are particularly likely to suffer in this way. It is claimed, however, that wheat grown on this soil is of the good hard quality preferred by millers. Buckwheat and oats would do well, as would onions and celery also. Tomatoes do only fairly well. Rather heavy applications of lime—from 40 to 60 bushels per acre—at frequent intervals are required to bring the soil up to its maximum producing capacity. Deep plowing is said to be quite beneficial. The improved land can be bought at about \$15 to \$30 an acre.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Portsmouth sandy loam:

Mechanical analyses of Portsmouth sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17910.....	Soil.....	1.2	24.2	26.0	26.5	1.9	12.5	7.3
17911.....	Subsoil.....	1.1	16.4	20.8	35.5	5.1	12.7	7.7
17912.....	Lower subsoil..	2.0	17.0	20.7	45.6	5.0	7.0	2.7

A determination of the organic matter gave the following percentage: No. 17910, 3.48 per cent.

PORTSMOUTH LOAM.

The Portsmouth loam consists of a rather spongy black loam so high in organic matter as very frequently to approach quite nearly the characteristics of a muck soil. Small areas of Muck do occur here and there. At 12 to 24 inches the soil passes into a dark-gray sandy loam carrying strata and pockets of clayey material, and this in turn at 30 to 36 inches generally passes into a grayish, compact, sticky coarse sand or sandy loam. The type is not extensive and occurs closely associated with the Portsmouth sandy loam having the same topography as well as being the result of the same processes. The most important area is that along Long Marsh Branch—the boundary line between upper Caroline and Queen Anne counties. This area has been effectively drained and is producing good crops of corn. The other bodies are largely in a semiswampy condition. The type when drained is well suited to strawberries, corn, dewberries, and buckwheat.

The following table gives the results of mechanical analyses of the soil and subsoil of the Portsmouth loam:

Mechanical analyses of Portsmouth loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17915.....	Soil.....	4.0	9.5	10.7	27.4	5.3	28.4	15.1
17914.....	Subsoil.....	3.6	26.4	22.3	23.0	1.1	16.3	7.6

MEADOW.

Wet alluvial bottom land having no uniformly definite texture and those areas near the heads of streams subjected throughout the year to standing water and swampy conditions have been classed as Meadow. A considerable proportion of the alluvial phase is susceptible to easy reclamation, and some of it is under cultivation. The upland bodies can be reclaimed by clearing, straightening, and extending the natural drainage ways. A few small areas are found along the water front just above tidal overflow. Generally every stream and drainage way has a narrow strip of Meadow from its mouth to its source. When thoroughly drained Meadow produces excellent corn and, where the organic-matter content is not too high, good grass and wheat.

TIDAL MARSH.

The areas of marshy land lying near water level and subject to tidal overflow are classed as Tidal marsh.

This land is a black or brown slimy loam, clay loam, or ooze, which is generally underlain at about 2 feet by a sandy or clayey material. The mass is pretty thoroughly interspersed with the roots of coarse grasses and cattails and decomposing vegetable matter. The whole remains saturated the year around. Considerable hydrogen sulphide is developed in the lower portion by decomposing vegetable matter. The odor can be very distinctly detected in the freshly exposed material, particularly in those areas touching salt water.

Tidal marsh occurs as narrow fringes along the larger bodies of water. The most extensive areas are found along the arm of Chesapeake Bay between Kent Island and the mainland and along the upper Choptank River.

The material is sedimentary in origin, having been deposited by rivers or built up by tides and waves. It can be reclaimed only by diking to keep out the tides. It supports a rank growth of coarse grasses and cattails. The grass is sometimes cut for hay.

SUMMARY.

The Easton area is situated in the central part of Eastern-Shore Maryland, between the Chesapeake Bay and the Delaware line. The total area is 618,560 acres. The topography varies from the low, flat, foreland country to the moderately rolling upland plain, which attains in some points altitudes of 80 feet. The lower division is much indented by rivers and bays. The upland country in general has very good drainage.

The climate is good. The mean annual temperature is 55° F., and there is a well-distributed rainfall of about 41 inches. The waters

abound in fish, oysters, and crabs, and the fishing industry is important.

The transportation facilities, both water and rail, are good. Public roads are good in summer and are kept, for the most part, in pretty fair condition throughout the winter.

The soils of the Easton area are among the most productive of the Atlantic Coastal Plain. Most of the soils are easily managed, hold improvement well, and respond readily to judicious treatment. For wheat the heavier Sassafras soils equal and frequently exceed the production of the fertile "black lands" of the northwestern wheat States. From 1 to 2½ tons of good hay can be produced on the heavier soils, while large yields of forage crops can be secured from all the types. There are no better tomato and trucking soils in the country than the lighter Sassafras soils, as is strongly emphasized in Caroline County, where about one-tenth of the total tomato pack of the United States is put up.

Attractive inducements are offered persons seeking soils adapted to special lines of farming, general farming, or the two in conjunction with stock raising. Butter-making should become permanent and profitable.

Named in the order of importance, wheat, corn, tomatoes, and hay comprise the general farm crops. A number of specialties like sugar corn and garden peas for canning, and strawberries, asparagus, cantaloupes, peaches, dewberries, and peas are grown for market. Cowpeas, alsike, crimson clover, and alfalfa are coming into use for forage and for improving the land.

The rotations commonly practiced are the three and five field systems, the former being corn, wheat and grass, and the latter corn, wheat, grass, wheat, and grass. Tomatoes, clover, and cowpeas can be introduced into the system profitably. It is a frequent and advisable practice to sow cowpeas or crimson clover in corn at the last cultivation. Wheat averages nearly one-third more after a clover-timothy sod and after tomatoes than after corn. It is not advisable to grow tomatoes after tomatoes.

Large quantities of commercial fertilizer are used. The grades for wheat, corn, and grass average something like 1-9-2 in analysis.

The price of land varies from about \$30 to \$75 an acre, according to location, the kind of soil, and state of improvement.

The Sassafras sand is a light, well-drained, and naturally warm soil especially adapted to truck crops like garden peas, asparagus, and early Irish potatoes. It is kept in best condition by turning under crops of cowpeas and crimson clover and applying barnyard manure at frequent intervals.

The Sassafras loamy sand is a gently rolling, light loamy sand well suited to sweet and Irish potatoes, strawberries, asparagus, dew-

berries, and sometimes producing fair crops of corn. It also requires the addition of considerable vegetable manure.

The Sassafras sandy loam is the most extensive and widely distributed type of the area, occurring throughout the uplands. It is an excellent general farming soil and the best tomato soil of the area. It is also especially suited to strawberries, potatoes, asparagus, peaches, pears, dewberries, and other small fruits. Under favorable conditions of weather and soil management, wheat yields from 15 to 30 bushels, corn from 35 to 65 bushels, hay from 1 to 2 tons, and tomatoes from 4 to 12 tons per acre. The type is easily handled.

The Sassafras loam is the best all-around general farming soil of the area, producing under favorable conditions 18 to 35 bushels of wheat, 40 to 75 bushels of corn, 1 to 2½ tons of hay, and an average of about 4 tons of tomatoes per acre. It is the best wheat and corn soil of the area. Peaches, pears, cantaloupes, and all kinds of forage crops yield well.

The Sassafras silt loam is an excellent soil. The surface is generally flat and sometimes requires ditching to remove surface water. It is the best grass soil and gives excellent yields of wheat and corn as well. The type is not particularly suited to truck crops, although tomatoes, cabbage, and some other vegetables do fairly well.

The Sassafras fine sandy loam is confined largely to the lower flat lands. The larger areas are found along the water front of Queen Anne and Talbot counties. Where the drainage is good the yields approximate those of the Sassafras sandy loam. It is, however, probably a better grass soil than the Sassafras sandy loam.

The Elkton sandy loam and Elkton loam are flat or depressed poorly drained soils that make poor yields under present conditions. They need to be drained and limed. The total area is not very extensive.

The Elkton silt loam produces good wheat and grass, but poor average crops of tomatoes and corn. The soil has the same texture and is derived from the same materials as the Sassafras silt loam, but poorer drainage has given rise to an unfavorable structure in the soil and an unhealthy, stagnant condition in the subsoil. The soil is benefited by turning under coarse manures and applying from 40 to 50 bushels of lime per acre to grass sod every three to five years. This soil should be used largely for growing grass and forage crops in connection with stock raising.

The Portsmouth sandy loam and Portsmouth loam are black, spongy soils of high organic matter content. When drained they produce excellent strawberries, dewberries, and corn. Winter crops, like wheat and grass, are apt to heave during alternate freezes and thaws. Considerable areas in northern Caroline County could be

reclaimed by deepening, straightening, and extending ditches and natural drainage ways.

Meadow constitutes the low, wet strips of land along streams and the flat, semiswampy bodies around the heads of streams. All of the latter and many of the strips along water courses could be reclaimed. Excellent corn can be grown on this type.

Tidal marsh consists of the marginal fringes along the shore line and larger streams subject to tidal overflow. The material generally consists of oozy sediments interspersed with roots of coarse marsh grass. In order to reclaim this type diking would be necessary to keep out tide water.

SOIL SURVEY OF THE MIDDLEBOURNE AREA, WEST VIRGINIA.

By THOMAS A. CAINE, E. R. ALLEN, H. JENNINGS, and G. W. TAILBY, Jr.

DESCRIPTION OF THE AREA.

The Middlebourne area is located in the northwestern part of West Virginia and includes Tyler, Wetzel, and Marshall counties, the last-named being the extreme southern county of the Panhandle. The area is bounded on the north by the Ohio River and Ohio County, on the east by Pennsylvania, and Monongalia and Marion counties, on the south by Harrison, Doddridge, Ritchie, and Pleasants counties, and on

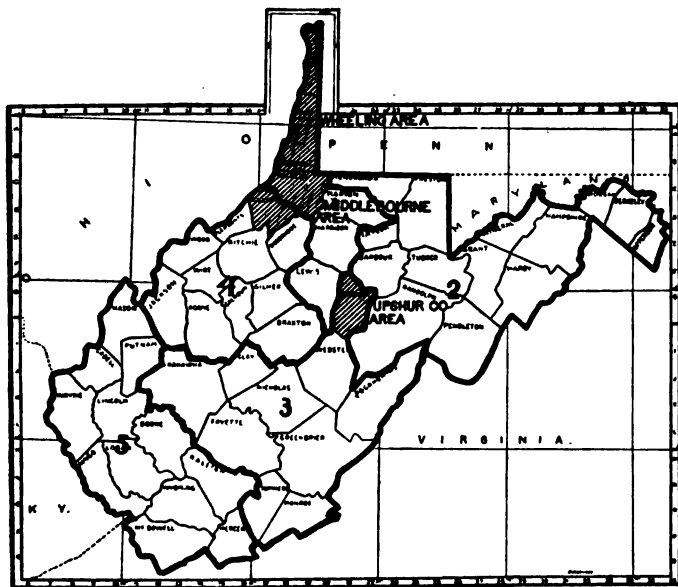


FIG. 4.—Sketch map showing location of the Middlebourne area, West Virginia.

the west by Pleasants County and the Ohio River. In a north and south direction it has a length of about 45 miles, while east and west its width varies from about 12 to 32 miles. Parallel $39^{\circ} 20'$ crosses the southern part of the area and 40° the northern part and meridians $80^{\circ} 25'$ and $81^{\circ} 10'$ west of Greenwich form the eastern and western limits, respectively. There are 609,536 acres or about 952 square miles in the area.^a

^a About 22 square miles of this was surveyed in the Wheeling area, but is included in the present map to complete Marshall County.

The most conspicuous topographic feature of the area is the narrow, meandering, gorgelike valley of the Ohio River, which extends in a northeast-southwest direction along the entire western border. The elevation of the river varies from 581 feet at the southern boundary to 610 feet at the northern boundary. The alluvial and terrace lands along the river are seldom over a mile wide, and as the river meanders back and forth the bottoms are found first on one side and then upon the other side of the stream. The hills bordering the river are steep and abrupt, and at those points where the channel runs close to the valley wall they are usually precipitous, often rising to an elevation of 400 to 600 feet in a distance of from one-fourth to three-fourths mile from the river.

Viewed from the hilltops the whole region presents a picturesque appearance, resembling a mountainous country in miniature. A close inspection, however, will show that as far as can be seen in all directions the highest points are all on about the same general level; and looking from one of the highest points, a mile or so back from the river across into Ohio, the deep, gorgelike, intervening valley is hardly perceptible. These nearly horizontal hilltops are the remnants of an ancient upland plain which has been reduced to its present highly dissected form by centuries of weathering and erosion.

The drainage of the area is all into the Ohio River, principally through Wheeling, Grave, Fish, Fishing, and Middle Island creeks. These creeks all pursue roughly parallel northwestern courses, but make a sharp bend to the southwest just before entering the river. They are very crooked and wind back and forth, often making loops of a half mile or so across. These creeks are still deepening their channels to the level of the Ohio River. In an air-line direction they have average falls varying from 15 to 30 feet per mile. In places their channels rest upon bare rock. On the inner bends of the loops there are often narrow strips of rich alluvial land and the hills back of these are less precipitous than on the outer bend, where erosion is more active. Here the hills are steep and precipitous, and whenever there happens to be a heavy, massive stratum of sandstone high up in the hills, it usually breaks off in huge, angular blocks, with which the hill-side and the creek bottoms below are strewn.

Frequently within the loops of these large streams and a hundred feet or more above their present channels the same heavy, massive sandstone stratum, because of its resistance to weathering, forms a distinct table land, and gives rise to a peculiar character of soil. These larger creeks all have high valley walls with steep, sloping sides, and are, if anything, more gorgelike than the Ohio Valley. The hills rise abruptly from 200 to 400 feet a short distance back from the streams.

The drainage basins of the large streams are made up of an irregular network of smaller streams, which usually flow on bedrock through

straight, deeply-carved V-shaped channels. The depth of these valleys varies from 100 to 300 feet, and the fall per mile of the streams is often greater than 100 feet. The streams are rapidly cutting their channels deeper, hence there is seldom any bottom land along their courses. The main roads often lie in these valleys. In some places the valley floors are so narrow that the stream beds are utilized as the road, and where the stream ends the road winds up to the top of the divide only to descend immediately into the next valley. In the central portion of the area the divides between the main drainage basins are narrow and winding, the streams on both sides having cut back so far as to interlock, resulting in the formation of a series of long, narrow, detached hills and knobs along the top of the divide. In this same portion of the area the ridges between the smaller creeks and branches are long, narrow, and angular. In the northern and southern portions of the area, however, the divide between the main drainage basins and the ridges between the smaller streams are broader, the knobs and hills are less conspicuous, and the region is much better adapted to general farming. One of the highest points in the area is Honsocket Knob, which has an altitude of about 1,625 feet, so that within the area there is a total range in elevation of over 1,000 feet.

The first permanent settlers in the area came from Virginia, Maryland, and North Carolina about 1775, and located at different points along the Ohio River, principally near the present sites of Moundsville and New Martinsville. For the first fifty years following 1775 many more came from the same States, being attracted by the rich lands and the transportation advantages afforded by the Ohio River. The present farming population, comprising about 60 per cent of that of the whole area, is mainly descended from the original settlers, with a sprinkling of those of German and Irish extraction. The remainder of the population are those who, being attracted by the good wages paid in the oil, gas, coal, glass, pottery, and iron industries along the river, have come in recent years from various parts of this country and of the Old World.

When the original thirteen States were organized the area fell within the territory of Virginia and remained a part of that State until the formation of West Virginia in 1863. The whole area was originally within the limits of Ohio County, which was organized in 1785 and at that time included not only all of the Panhandle, but extended indefinitely westward and for a considerable distance to the south. After the formation of the State of Ohio the westward extension of Ohio County, Virginia, became fixed by the Ohio River. In 1814 Tyler County, named in honor of President Tyler's father, was formed from a part of Ohio County and included what is now Tyler and Wetzel counties. In 1835 Marshall County, named in honor of John Marshall, was organized from the southern portion of Ohio County. In 1846 Wetzel County was formed from a part

of Tyler County by act of the Virginia assembly. All three of these counties have an excellent frontage on the Ohio River, and thus even before the advent of railroads they were favored with the best means of transportation that the time afforded.

Until about twenty years ago little had been done to develop the natural resources of the area. Since then petroleum and natural gas have been found in vast quantities and are being extensively developed in the southeastern part of the area, while in the northern part along the Ohio River the iron, steel, and glass industries are yearly becoming more important. There are immense quantities of coal and considerable fire clay under the whole area, and these await development. In recent years the growth of the towns along the Ohio River has been rapid, and some new towns have sprung up, this being especially true in the vicinity of the iron, steel, and glass plants. The original forest growth of the area has practically all been removed, though in the central portion, where much of the land is too steep, broken, and rough even for profitable use as pasture, the landowners have very wisely permitted large areas to become reforested.

The superior shipping facilities afforded by the Ohio River have been and always will be an important factor in the development of the region, and at present there are several steamboat landings within the area. There are also many desirable sites along the river for the location of steel, iron, glass, and pottery plants or factories. The Ohio River division of the Baltimore and Ohio Railroad runs the full length of the area on the West Virginia side of the river and connects the towns of Moundsville, New Martinsville, and Sistersville with Wheeling on the north and Parkersburg on the south. The West Virginia Short Line of the Baltimore and Ohio system crosses the southern part of Wetzel County and connects New Martinsville with Clarksburg, and the Wheeling Short Line, which crosses Marshall County and a part of Wetzel County, connects Moundsville with Fairmont. There are also two trolley lines in the area, one extending from Moundsville to Wheeling and the other from Sistersville to New Martinsville.

The chief towns of the area are McMechen, Moundsville, New Martinsville, and Sistersville, all of which are located on the Ohio River. There are also several other thriving little towns, the largest of which are Cameron, Hundred, Middlebourne, Pinegrove, Jacksonburg, and Smithfield. These towns and Wheeling furnish a greater demand for general farm and dairy products and truck crops than is at present being supplied by the agricultural population of the area.

CLIMATE.

The climate of the Middlebourne area is well suited to the carrying on of general farming. The winter weather is cold and there is

often considerable snow, but it can not be said that the climate is severe. It is seldom that the temperature goes below zero, and the average for the three coldest months—December, January, and February—is about 32° F. The other extreme is rarely higher than 100° F.

The average length of the growing season is between six and one-half and seven months, and not infrequently stock may be pastured for eight months of the year.

According to the data given in the accompanying table for New Martinsville, the average annual precipitation is about 39 inches, and during October and November the average monthly rainfall is about 2.7 inches. This is sufficient to germinate wheat and rye and get them well started and rooted before the winter sets in. The table shows also that the average monthly precipitation for December, January, and February is about 3 inches. A considerable part of this is in the form of snow, which protects the ground from much hard freezing and thawing. April has an average rainfall of 3.4 inches, and May is usually warm and pleasant, with an average rainfall of 3.5 inches, which is sufficient to germinate the corn and oats. It is seen also that in June, July, and August the average monthly temperature is about 74° F. and that the average monthly precipitation is about 4 inches. This is ample warmth and moisture for the growing and maturing of oats, wheat, rye, and hay. The least precipitation occurs in the fall after the close of the growing season, while the greatest occurs when the growing crops need it most. A failure of the staple crops on account of drought is very rare, and it is likewise very seldom that the rains are so excessive during the spring and summer months as to prevent the completion of plowing and sowing or seriously to damage hay and grain during harvest.

Normal monthly and annual temperature and precipitation.

Month.	New Martinsville.		Central Station. ^a		Bens Run. ^a	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	° F.	Inches.	° F.	Inches.	° F.	Inches.
January.....	32.0	3.12	37.0	3.60	38.3	3.42
February.....	30.7	2.96	30.6	1.40	32.0	2.10
March.....	42.7	3.32	35.7	3.98	37.2	5.06
April.....	52.9	3.44	52.6	3.18	54.6	3.62
May.....	63.6	3.54	61.9	2.00	64.0	6.89
June.....	72.1	3.85	70.1	4.58	72.4	5.82
July.....	75.8	5.42	71.6	3.32	74.7	3.27
August.....	74.9	2.93	75.2	4.72	77.7	8.62
September.....	68.0	2.42	69.0	2.76	72.0	1.64
October.....	56.0	2.09	54.3	1.86	55.8	3.22
November.....	44.1	3.35	42.5	2.34	44.7	2.52
December.....	34.8	3.19	35.0	4.51	35.8	5.60
Year.....	54.0	39.63	53.0	38.25	54.9	51.78

^a The figures given for Central Station and Bens Run represent the temperature and precipitation for the year 1906, without departures from the normal.

Dates of first and last killing frosts.^a

Year.	New Martinsville.		Wheeling.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1898.....	May 9	Oct. 24	Apr. 8	Oct. 28
1899.....	Apr. 10	Oct. 1	Apr. 5	Oct. 1
1900.....	May 4	Oct. 17	Apr. 10	Nov. 14
1902.....	Apr. 15	Oct. 15	Apr. 8	Oct. 22
1903.....	Apr. 24	Oct. 25	Apr. 5	Oct. 25
1904.....	Apr. 22	Oct. 7	Apr. 21	Oct. 28
1906.....	May 10	Oct. 12	May 7	.....
Average.....	Apr. 26	Oct. 14	Apr. 13	Oct. 25

^a Data of frost occurrence at Central Station and Bens Run were too fragmentary to have any significance and are therefore omitted from above table.

AGRICULTURE.

The early settlers confined themselves largely to the Ohio bottoms and to the easily tillable land for a few miles back from the river. They found the soils very well adapted to wheat, corn, and rye, and the growing of these crops constituted the main type of farming for the first fifty years following 1775. Over the larger portion of Wetzel and Tyler counties, however, there are large areas, especially within the drainage basin of Fishing Creek, where the hills are so steep and the ridges so narrow that the land has remained in the original forest or the areas once cleared have been reforested. It is within this poorest agricultural portion of the area that great bodies of oil and gas have been exploited in recent years.

During the first quarter of the last century the production of wheat, corn, and rye outgrew the local demands, but with the establishment of river transportation with the older colonies of the lower Mississippi a large flour and whisky trade was built up.

About 1840 grain growing is said to have become unprofitable because of the constant improvident cropping of the soils. The wheat yields had fallen off year after year from 35 bushels to about 10 bushels per acre, and other grain crops had decreased in like proportion. Considerable land was abandoned as "worn out" and allowed to grow up to weeds and brush, and for a time the production of grain scarcely sufficed to supply the local demands.

About this time (1835) a number of Merino and Saxony sheep were introduced, and the industry was so profitable that it spread in all directions and became very important in Virginia, Pennsylvania, and Ohio. Nearly every farmer kept some sheep and a number of those who owned large flocks became comparatively wealthy. Wool answered the commercial requirements of the time, since it was not exceedingly bulky, could be handled easily, was nonperishable, and in great demand. The wool or the manufactured woolen products

were readily exchanged in the southern markets for sugar, molasses, and cotton. Some of the area has always been considered a little too steep and broken for heavy stock, but admirably well adapted to sheep raising, which for a number of years was the most important industry, little attention being paid to other lines of agriculture. It was found that after being pastured to sheep a number of years the "worn-out" soils were greatly benefited, and some claim that they became more productive than ever. By this time the whole region had made marked progress in settlement and in industrial enterprises, and with the increase in population there arose a great demand for all kinds of farm produce, especially dairy products, fruit, and truck crops. A reduction in the price of wool caused sheep raising to become less popular and the wool industry no longer constitutes the principal pursuit. However, it is still an important auxiliary to general farming, especially among the most progressive and prosperous farmers, who use this means of maintaining the productivity of their soils.

Taking the area as a whole, there has been no increase in the acreage of wheat, corn, and oats during the last twenty years, and in fact the acreage seems to have been reduced within the last ten years, notwithstanding the ruling higher prices of these products. In the vicinity of Wheeling, Moundsville, New Martinsville, and some of the other towns a few of the farmers are striving to supply the increasing local demand for milk and butter, fruit of all kinds, and truck crops. There are no commercial orchards within the area, but judging from the few scattering, poorly kept orchards, and also from the similarity of climate and soils to those in the northern end of the Wheeling area, where there are several successful commercial orchards, there can be no doubt that the soils along the Ohio River, as well as most of the soils found in the hill sections of the area, are well adapted to the production of such varieties of apples as the Stark, Ben Davis, and Rome Beauty. It is also recognized that a considerable part of the upland areas is well adapted to dairying, but owing largely to the confining nature of the occupation, lack of intelligent labor to handle the stock, and the steep, rough roads to market, this industry is limited to the farms convenient to towns. The more level upland soils are fairly well and the terrace soils along the Ohio River admirably adapted to truck and berry crops, as well as to general farming. At present, however, very little attention is being paid to trucking in either of these localities, and most of the fruit and vegetables sold in the larger towns along the river is shipped in from outside points.

On the upland farms the more level part is usually fenced off from the steeper hillsides and used for general farm crops. The steeper hillsides are usually seeded down to grass and used for pasture or the

production of hay. Some of these hillsides have been furnishing excellent pasturage for over twenty-five years. Below these pasture fields and adjacent to the streams on both sides there is usually considerable Rough stony land which affords scant pasture and which is often permitted to grow up to locust and other trees or to remain covered with its original forest growth. In the central portion of the area most of the steep slopes and narrow ridges remain in timber.

The usual crop rotation upon the tillable uplands is one year each of corn, oats, and winter wheat. A limited acreage of potatoes is grown. Timothy is sown in the fall with the wheat, and clover is sown the following spring. The first year the meadow consists largely of clover, but the following year the timothy predominates and is left as long as it will yield a profitable crop, usually from three to five years. On the soils derived from calcareous shales, as the timothy thins out Kentucky bluegrass takes its place. The latter is never cut for hay, but makes excellent pasture, being much better than the Canadian bluegrass, which is also abundant in the area. The length of time a field remains in pasture depends upon the size of the farm, the amount of stock kept, and very much upon the location of the field and the character of the soil. The most successful farmers try to keep land seeded down as long as possible, and to keep enough stock to consume the greater part of the hay, straw, and grain.

There are a few custom flour mills in the area, but practically all of the farmers sell their wheat and buy flour imported from other States. This has led a few to abandon wheat growing and to substitute a yearly rotation of corn and oats. Timothy and clover are sown in front of the drill with the oats, and usually two excellent crops of clover are secured the next year. In the cultivation of the steeper slopes the farmers, as a rule, cultivate the upper half one year and the lower half the following year. This is done to keep washing and gullying in check, and whatever wash occurs from the upper half of the field the first year is caught in the grass and sod of the lower half of the field and adds to its fertility for the following year. When the steeper slopes are broken for corn the best farmers leave one and sometimes more narrow strips of sod about the middle of the field and following the contour of the hill; and where there are slight depressions, old gullies, or little runs they are likewise left in sod, and the brush and stones which accumulate in the field are usually disposed of by dumping into these depressions to aid in checking further gullying and erosion.

On many of the slopes of the Rough stony land the influence of the underlying more resistant shaly sandstone is quite marked, giving rise to a series of horizontal natural terraces. The level part of the terraces consists of a narrow strip of very productive

soil, while the part too steep for cultivation is kept in sod for the protection of the better lying strips.

Very little commercial fertilizer is used, but all of the farmers recognize the great value of stable manure in maintaining the productivity of the soils. Many admit that it would be better for their farms if they kept more stock. In the trucking areas no rotation is practiced, and the productivity of the soils is maintained by manure hauled from the towns. The level areas along the streams are not subject to serious erosion, and their productivity is maintained by occasional overflows and by frequent heavy applications of manure.

The adaptation of the methods to the present conditions on the rolling uplands is well illustrated in the case of the corn, practically the only clean-cultivated general farm crop in the area. The sod is broken to a depth of about 7 inches, and the corn is either drilled or dropped in rows running with the contour of the hills, so as to aid in checking erosion. During the first year the sod roots aid in binding and holding the soils, and recognizing this fact the farmers seldom plant corn two successive years upon the same field, because the sod roots would be thoroughly rotted the second year and washing and gulying would be serious.

The low prices paid for wool, the rapid industrial development of the region, and the increased demands for agricultural products have completely changed the agricultural conditions during the last quarter of a century. Landowners throughout the area are quite prosperous, as shown by the low percentage of mortgaged farms. Their dwellings and barns are usually quite substantial, the farms are well supplied with good draft horses, and there is an abundance of up-to-date farm machinery in use. In recent years returns from the sale of the underlying coal and the rentals and royalties from gas and oil have added to the income of the farmers, and their prosperous condition at present is due in part to this.

The great demand for laborers in the factories, mills, potteries, blast furnaces, and mines, and in the oil and gas industries has attracted many people from adjoining States and caused young men to leave the farms to engage in these various pursuits because of the shorter hours and better pay. The scarcity of good farm labor is one of the most serious drawbacks to farming. The wages paid farm hands range from \$20 to \$30 a month, with board, lodging, and washing, and often feed for a driving horse. The most successful farmers feel the necessity of arranging their farm practice in such a way as to hire as little labor as possible. About 75 per cent of the farms are operated by the owners, the remainder being rented for cash or on shares. Throughout the area, especially in the central part, there are considerable tracts of wooded land which

are too steep and broken for cultivation. The average size of the farms is about 100 acres. The size of the holdings, however, ranges from a few acres to over 1,000 acres.

There has been a great increase in the selling price of the farm lands within the last fifteen years. Improved farms are now selling for as much per acre without the coal, oil, or gas privileges as they did fifteen years ago with all of these privileges. Unimproved farm lands with the above-mentioned rights could have been purchased fifteen years ago for about \$15 an acre. With the coal, oil, and gas privileges these same lands now bring from \$50 to \$100 an acre, depending upon location. The whole area is underlain by the Pittsburg coal, and the coal rights on most of the farms have been sold. In the best farming sections of the area the average price per acre for improved farms without coal, oil, or gas rights is about \$50. The price, however, varies considerably, depending upon the kind of soil and the nearness of the farm to town.

At present the live-stock interests of the area are not as important as formerly. Some cattle, sheep, and hogs are kept by every farmer, but on most farms the number could be profitably increased. The stock is usually of good quality, including the farm horses, which are well bred and well cared for.

Until about twenty-five years ago the production of sheep for wool or mutton was one of the most important industries. At present there are about one-third as many sheep in the area as formerly. Practically the only breeds raised are the Delaines and the Merinos. These give a good yield of wool, and the lambs, which are marketed in the fall, bring from \$2 to \$3 a head when six months old. It is believed that the number of sheep could be profitably increased where protection from dogs can be had, and also that goats would prove a good investment in the rougher parts of the survey.

The dairy interests are confined almost exclusively to the territory immediately surrounding the towns and villages. Not many blooded cows are kept. The dairymen usually live close to town and retail milk at 5 to 8 cents per quart, the price depending somewhat upon the season of the year. The present local supply of milk is barely sufficient to meet the demand in some of the towns, and it seems that this industry could be profitably extended.

Some farmers sell annually in the local markets a few fat steers and calves. Only a few hogs are raised, but in parts of the area where corn is grown in abundance more hogs could be raised with profit.

As a rule, the farmers understand how the different soils should be handled to maintain their productivity and to bring the largest returns. On the Meigs clay loam the fields should seldom if ever be plowed, and it would be better to keep them either in orchards or pasture. On the Rough stony land it is believed that the greatest profits are to be had by pursuing systematic forestry, and that growing

locust trees for posts would be especially profitable. Orchardng should receive more attention. Practically all of the farmers recognize that it would be better to keep more stock and feed their roughage at home instead of selling, even at high prices, all available hay, straw, and grain to the teamsters in the oil and gas fields.

SOILS.

The soils of the area fall naturally into three general divisions. The first and most important is that comprising the residual upland soils, which occupy fully 90 per cent of the area, and are found in all locations from the gently rolling hilltops to the steepest hillsides. Geologically, the uplands belong to the Coal Measures of the Carboniferous age, and that part of the Coal Measures here represented belongs to the Dunkard series (Permian). Several upland soil types were found, each differing from the others in texture, topography, and agricultural value, and each requiring different methods of treatment in the way of cultivation and fertilization in order to insure the best yields.

The Dunkard series is composed largely of a brown and a gray micaceous sandstone which is very easily disintegrated. In Marshall County these sandstones are interstratified with limy shales, which upon weathering result in soil of relatively high lime content, and for this reason, as also because of the more gentle topography, the soils are considered better for general farming than those farther south.

In Wetzel County, especially, the sandstone and sandy shales are interstratified with numerous beds of marly red shales, holding concretions of lime, and because of the easily eroded character of these formations they give a very rugged topography and are better suited to forestry, grazing, and fruit culture than to general farming. Large areas of this region are forested with second-growth timber, nearly all of the original timber having been removed. Occasionally small cleared spots may be seen even upon some of the steeper slopes, and for the first year or two the crop yields upon these are surprisingly large, but unless kept in pasture the soil soon washes off and exposes the underlying shales and sandstones.

In the region where the limy shales are most abundant the soils are best for wheat, corn, oats, hay, and pasture and support a permanent bluegrass sod. The soil derived from the marly red shales is also well adapted to these crops and supports an excellent bluegrass sod, but owing to rapid erosion it is found only in narrow areas, a rod or so wide, running horizontally around the hills. Very often the sandstone and sandy shale fragments from above have become so thoroughly mixed with this soil that it is difficult to recognize it. The soil derived solely from sandstone is limited in extent and occurs as isolated patches, principally in shelflike positions 100 feet or more above the main streams.

The second of the three general divisions of soils found in the area occurs in the form of terraces along the valleys of the Ohio River and its larger tributaries. Along the river the terrace material is composed largely of glacial sand, silt, and gravel brought down by the glacial floods. Along the tributary streams, however, the terrace material, though deposited at the same time as the river terraces, was not brought from a glaciated region, but was derived from the soft, easily weathered sandstones of the Dunkard series, and hence the difference in the resulting soils.

The terrace soils of the Ohio River are represented by the Wheeling gravelly loam, the Wheeling sandy loam, and the Wheeling silt loam, while the terraces of the tributary streams are represented by a single type, the Tyler silt loam.

The third division of soils comprises the recent alluvial deposits in the valleys of the Ohio River and its larger tributary streams. The resulting soil types are the Huntington loam and the Huntington fine sandy loam. The latter occurs in narrow strips bordering the river and represents areas where the coarser materials, such as sand and vegetable matter, were deposited in times of flood. The Huntington loam is often found farther back from the stream areas where the finer materials—fine sand, silt, and clay—were deposited by quieter currents. In the Ohio Valley these two soil types, as shown by various excavations, are found as a veneer over the sandy and gravelly terrace materials.

Along the small tributary streams only patches of soil are found, and these are usually too small to be shown upon a map of the scale used. Along the larger streams, such as Wheeling, Grave, Fish, Fishing, and Middle Island creeks, there is considerable bottom land. The channels of these streams are nearly level with the Ohio River, and the valleys in places are a half mile or more in width. The bottoms are all subject to overflow, and the soil formed there, though often rather variable in texture, is a loam having the characteristics of Huntington loam.

The following table gives the names and the actual and relative extent of the different soil types:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Meigs clay loam.....	281,280	46.2	Wheeling gravelly loam.....	2,240	0.4
Rough stony land.....	263,104	43.1	Upshur clay.....	1,856	.3
Huntington loam.....	25,152	4.1	Brooke clay loam.....	1,024	.2
Dekalb loam.....	24,512	4.0	Huntington fine sandy loam..	640	.1
Dekalb silt loam.....	3,712	.6	Wheeling sandy loam.....	192	.0
Tyler silt loam.....	3,008	.5			
Wheeling silt loam.....	2,816	.5	Total.....	600,536	.....

DEKALB LOAM.

The soil of the Dekalb loam, to an average depth of 8 inches, consists of a light-brown to gray silt loam, usually very mellow and loamy. The subsoil from 9 to 15 inches is lighter in color and more compact, but similar in texture to the soil. Occasionally the subsoil is a silt loam to 20 or 24 inches, but usually becomes heavier at about 15 inches, below which it is a brownish-yellow to yellow compact silty clay to clay loam. Brown, gray, and red mottlings are found throughout the lower subsoil. When wet the subsoil is plastic, but when dry the silt content is sufficient to make it friable. The characteristic feature of the subsoil is the soapy feel, due to the soapstone in the formation from which the type is derived. Small mica flakes are also thickly interspersed throughout the subsoil. At a depth of 4 to 6 feet the Dekalb loam rests on a mass of broken shale and sandstone fragments, beneath which is the bed rock. Scattered over the surface and through both soil and subsoil are small shale and sandstone fragments, but these are never numerous enough to interfere with cultivation. In many parts of the type stones are almost entirely absent. The soil is not difficult to cultivate, and when properly handled there is no trouble from puddling or baking.

With the exception of a few small areas in the southwestern part of Tyler County, the Dekalb loam is confined to Marshall County, and is best developed in the northern half, where the ridges and hilltops are broader and the surface is not so badly eroded by streams. This type is found only on flattened hilltops and wide ridges, where the rate of weathering of the underlying rocks is more rapid than the erosion. On the steeper slopes erosion carries away the soil as rapidly as it is formed and thus exposes the subsoil and underlying rock fragments. Such areas were mapped as Meigs clay loam. These two types naturally merge into each other, no distinct dividing line being possible. The farmers have recognized the difference between them, and very often the fences separating the cultivated land from the pasture land are the dividing lines between the Dekalb loam and the Meigs clay loam. The topography of the Dekalb loam is such as to furnish ample drainage.

In this area the Dekalb loam is derived directly from the underlying shales and sandstones of the Dunkard formation of the Coal Measures. The fine-grained shales and sandy shales predominate, giving this type a heavy subsoil. The original timber growth consisted largely of red and white oak, hickory, poplar, maple, and beech. There was also some chestnut. Practically all of the type is cleared at present.

With the exception of Brooke clay loam, the Dekalb loam is the most productive upland soil in the area, and is well adapted to all of the

farm crops grown in this region. In order of importance, the crops are hay, corn, wheat, and oats. Hay yields 1 to 2 tons per acre, with an average of about $1\frac{1}{2}$ tons; corn from 30 to 60 bushels, with an average of 40 bushels; wheat 10 to 25 bushels, with an average of 12 to 15 bushels; and oats 20 to 40 bushels, with an average of 30 bushels per acre. Some potatoes, fruit, and vegetables are grown, mostly for home consumption.

The farmers well recognize the fact that to prevent erosion and to maintain the productive power of the soil it must be kept in grass as much as possible. The usual rotation is corn, wheat, and hay, the land remaining in meadow or pasture from three to six years. A field is thus in corn not more than one year out of five or six.

Some of the farmers have used commercial fertilizers to a slight extent, principally on the wheat, but they say that after once fertilizing a field more and more must be added each year to maintain the yields, and for this reason the use of commercial fertilizers has been practically abandoned. Stable manure is used in small quantities and gives excellent results. However, as only a few animals are kept on the farms the quantity of manure produced is very limited. A few farmers near the cities find it profitable to haul manure from the livery stables. It is important that all available manure be preserved and applied to the soil.

The northern end of the area, where the Dekalb loam is the prominent soil, is the most prosperous from an agricultural standpoint. The most desirable upland farms of the area are those which contain a large percentage of this type for the general farm crops and a sufficient area of Meigs clay loam for pasture.

The average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Dekalb loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
17675, 17677.....	Soil.....	0.2	2.4	1.3	3.0	8.9	65.6	17.9
17676, 17678.....	Subsoil.....	.9	3.0	1.9	5.6	11.6	45.9	30.7

DEKALB SILT LOAM.

The soil of the Dekalb silt loam is uniformly a light-brown mellow silt loam with an average depth of about 8 inches. The subsoil to a depth of 36 inches or more is either a very light brown or a pale-yellowish material, varying in texture from a silty loam to a silty clay loam. The soil is quite similar in texture to that of Meigs clay loam, but the subsoils of the two types are very different both in texture and color. Sometimes small fragments of sandstone and sandy

shale are found in the soil and subsoil and scattered upon the surface, but this is not a conspicuous characteristic of the type, and rock fragments are never numerous enough to interfere with plowing.

The Dekalb silt loam is not a widely distributed soil, being usually found only in small areas. In the present survey it generally occurs upon narrow ridges or in small shelflike positions 100 feet or so above the larger streams. It is a residual soil derived from the weathering of some of the heavier, massive sandstone strata of the Dunkard series, and the usual topography is nearly level to gently rolling and in a few places slightly hilly. It is a well-drained soil and absorbs moisture well. It is slightly droughty, however, in a dry season.

The original forest growth was chestnut and oak. At some time or other all of the type has been under cultivation. It is not considered an especially good soil for any particular crop, but when handled carefully and well manured it is a fair soil for all general farm crops of the region. Corn yields from 25 to 60 bushels per acre, oats from 20 to 50 bushels, wheat from 10 to 25 bushels, and potatoes from 50 to 150 bushels. Apples, cherries, plums, berries, and garden vegetables all do well, but are grown only for home use, the same being true for strawberries and raspberries. It is believed that the growing of strawberries, raspberries, early potatoes, and vegetables for market would prove profitable on this soil.

In the early days of the settlement of the region the Dekalb silt loam was not so rapidly taken up and cleared as the limestone soils to the north in Burke and Ohio counties or as the Dekalb loam nearer by. This was due largely to the general recognition of the fact that soil derived from sandstone is usually not as productive as that derived from limestone or marly or limy shale. Sheep raising never was popular upon this soil, for the reason that bluegrass does not thrive upon it.

The soil is slightly acid or "sour," and could be improved by applications of lime and manure and by the growing of clover. At present clover does not obtain a good stand and soon dies out. As the type is not of large extent it has no great influence upon the general agricultural conditions and value of farm lands in the area.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil:

Mechanical analyses of Dekalb silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
17136.....	Soil.....	0.1	1.1	1.5	10.7	9.5	62.6	14.3
17137.....	Subsoil.....	.1	1.1	1.5	12.9	12.2	52.3	19.7

WHEELING SILT LOAM.

The soil of the Wheeling silt loam to an average depth of 12 inches is a loose, mellow, brown or yellow-brown silt loam, often containing some fine sand. The subsoil from 12 to 36 inches varies from a silt loam to a clay loam, but is usually a brownish-yellow to yellow, compact silt loam. Below 24 inches it sometimes contains considerable fine sand, and in places becomes nearly a pure fine sand at 36 inches. A part, if not all, of the type is underlain by sand and gravel at varying depths below 3 feet.

The Wheeling silt loam is confined to the higher terraces along the Ohio River, the largest and most typical areas occurring on the second bottoms, usually on the same level or slightly lower than the Wheeling gravelly loam. In some localities there is no distinct terrace separating the Huntington loam from the Wheeling silt loam, and here the dividing line between these two types is indistinct. Narrow strips of the Wheeling silt loam are sometimes found between the Wheeling gravelly loam and the foot of the hills, and other areas are located on a still higher or third terrace, as at Steelton, 3 miles north of New Martinsville. Wherever the soil occurs as a high terrace bordering the foot of the valley hills it is usually considerably eroded by the small streams and drainage from the bordering hills, its characteristic level topography is lost, and it becomes gently rolling and in places irregular in surface. Where this is the case the soil is lighter in color and is slightly more sandy than the average of the type. On account of elevation above the river it is not overflowed, and its position, together with the gravelly and sandy substratum, gives fairly good drainage. However, near the base of the hills, where the drainage water collects, there are narrow areas so low and wet as to be entirely unfit for cultivation. If drained, these areas would be as productive as the rest of the type.

The Wheeling silt loam is an alluvial deposit of the Ohio River, being laid down after the glacial gravel was carried in, but at a much earlier date than the deposition of the Huntington loam, and at a time when the waters of the Ohio River were at a higher level than at present. Since then the soil has become weathered and has lost the characteristics of a first or overflowed bottom.

The Wheeling silt loam has all been cleared and is under cultivation. It is one of the most productive soils in the area, being well adapted to potatoes, corn, wheat, and hay. Oats are produced to a slight extent. Potatoes yield from 150 to 225 bushels per acre, with an average of 175 bushels; wheat 15 to 25 bushels, with an average of 18 bushels; corn 50 to 80 bushels, with an average of 65 bushels, and hay 1 to 2 tons per acre. One of the rotations practiced by the farmers on this soil, and one which is to be highly recommended, is as follows: Corn or potatoes, wheat, clover, and timothy. The first year the hay is mostly clover;

in succeeding years it is mostly timothy. The land is left in grass three years or more, which practice has proved beneficial. Stable manures give excellent results, but commercial fertilizers are not used. The farmers living on the bottom lands of the Ohio River are prosperous and well to do. Their farms, containing some hill land, sell for \$80 to \$100 an acre. The bottom land alone could not be bought for less than \$150 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Wheeling silt loam:

Mechanical analyses of Wheeling silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
17142, 17696	Soil.....	0.2	1.0	0.6	5.3	8.1	69.3	14.8
17143, 17696	Subsoil.....	.0	.1	.3	7.7	13.4	59.1	19.1

WHEELING GRAVELLY LOAM.

The soil of the Wheeling gravelly loam has an average depth of about 8 inches and consists of a brown loam usually containing considerable fine gravel and coarse sand. Local variations occur in which the soil contains considerably more than the average quantity of silt, or where the sand content is rather high, in such places the interstitial material ranging from a silty loam to a heavy sandy loam. The subsoil to a depth of several feet is a light-brown or yellowish gravelly loam. The gravel particles vary in size from one-fourth of an inch to 4 inches in diameter and consist largely of waterworn shale and rounded fragments of the harder rocks. Occasionally these shale and rock fragments are strewn over the surface, but never to a sufficient extent to interfere with cultivation. On the whole, the type is a loose, porous soil, easily handled, and never too steep for tilling.

The Wheeling gravelly loam is confined to the terraces of the Ohio River and occurs usually as long, narrow strips whose elevation above the low water of the river ranges from 40 to 80 feet. Its topography varies from nearly level to rolling and hilly. The loose, open nature of the subsoil insures good natural drainage, which over the hilly portion of the type is rather excessive. This type consists of reworked material brought from the glacial region to the north when the volume of the river was greater than now. The sand, gravel, and stones found beneath the surface represent approximately the character of the original deposits. The surface soil, however, has been more or less modified by weathering of the gravel and by an accumulation of organic matter since deposition,

thus making it a fairly good soil for general agriculture and trucking. It was originally covered with hardwood common to the region, but none of this forest is now standing. It was one of the soils first cleared in the early days, because it offered fine sites for buildings.

The Wheeling gravelly loam is better adapted to corn than any other general farm crop, the yields averaging about 45 bushels per acre. The yield of wheat ranges from 10 to 25 bushels, with an average of about 15 bushels, and of hay usually not more than 1 ton per acre. All general farm crops do better in a fairly wet season than in a dry season, as this soil is somewhat inclined to be droughty because of the loose, open, gravelly nature of the subsoil.

The soil is used to a limited extent for early truck crops, and judging from observation in this as well as in the Wheeling area it is evident that trucking on a more extensive scale would prove successful, especially as the large markets along the river are so near. Irish potatoes do especially well and yield on an average about 125 bushels per acre. Apples would no doubt do well, as would also plums, cherries, and pears. The soil needs careful attention in order to maintain its productivity. Barnyard manure is the only fertilizer used, and where applied in sufficient quantities the results are all that could be desired.

The Wheeling gravelly loam is not an extensive type, but its convenient location with respect to markets and its adaptation to truck, small fruits, and berries gives it some importance. Owing to its location along the river and the possibility of its future demand for factory sites, this type is held at figures usually beyond the reach of small farmers.

The results of mechanical analyses of fine-earth samples of the soil and subsoil of the Wheeling gravelly loam are given in the following table:

Mechanical analyses of Wheeling gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
17689.....	Soil.....	8.5	15.3	13.6	9.0	3.0	35.7	14.0
17690.....	Subsoil.....	10.4	24.2	20.9	9.9	4.0	18.2	12.8

WHEELING SANDY LOAM.

The Wheeling sandy loam consists of about 10 inches of light-brown sandy loam of fine to medium texture, underlain by a yellowish or lighter brown, rather incoherent sandy loam or sand to a depth of 30 inches, below which it often becomes a sticky sandy

loam. Owing to its loose loamy nature it possesses good natural drainage and is an easy soil to till.

The Wheeling sandy loam occurs as a terrace of the Ohio River, and is found in areas sufficiently large to be shown upon the map in only two localities—around Moundsville and west of Graysville. As the type is largely covered by the city there is no need of discussing it from an agricultural standpoint. A full discussion of the origin of the type and its especial adaptation as an apple soil may be found in the Report of the Soil Survey of the Wheeling area, West Virginia.

The results of mechanical analyses of samples of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Wheeling sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
17693.....	Soil.....	0.5	2.1	6.5	41.0	9.2	35.1	6.2
17694.....	Subsoil.....	.0	.4	3.6	42.7	10.9	34.5	7.6

TYLER SILT LOAM.

The Tyler silt loam is a variable type, the different phases being mapped together on account of the small extent of each. The soil to a depth of 10 inches consists of a dark-gray or brown mellow silt loam, underlain to 15 inches by a lighter gray or yellow silt loam. From 15 to 36 inches the subsoil varies from yellow or yellow-brown compact clay loam to a heavy plastic clay. In some places the subsoil is a yellowish sticky sandy clay, while in others, as along Middle Island Creek, it is a heavy silt loam, and below 24 inches contains considerable fine sand. The subsoil is often mottled gray and brown, has a soapy feel, and contains numerous small mica flakes. Part, if not all, of the type is underlain by rounded and flattened sandstone gravel, which is also scattered over the surface in a few places. Beneath the gravel is the bed rock upon which the soil was deposited by the stream. In a few places where erosion has carried away the soil the rock is exposed at the surface.

The Tyler silt loam is confined to the second bottoms along the larger tributary streams of the Ohio River, the largest areas being found along Middle Island Creek. These terraces are from 20 to 100 feet above the level of the stream and are never overflowed.

The areas of Tyler silt loam, at one time level, have been more or less dissected by streams and gullies caused by the drainage water from the slopes. Seepage and drainage water collects on the greater part of the areas, and the drainage conditions are very poor. This gives the soil the local name "crawfish land."

The Tyler silt loam is of alluvial origin, being deposited by the streams when their waters were at a higher level than at present. Some of the type near the base of the hills may be partly colluvial in origin.

The original tree growth, principally beech, has all been removed. When cultivated, about 35 bushels of corn, 25 bushels of oats, and from 1 to 1½ tons of hay per acre are produced on this soil. It is not well adapted to wheat. On account of the lack of drainage nearly all of the type is in meadow or pasture. Thorough underdrainage and liberal applications of stable manure would greatly increase the yields of all crops.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of the Tyler silt loam:

Mechanical analyses of Tyler silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
17138, 17687.....	Soil.....	0.2	1.5	1.2	6.5	7.0	66.6	16.4
17139, 17688.....	Subsoil.....	.1	.8	1.0	6.9	10.5	54.8	25.2

HUNTINGTON LOAM.

The Huntington loam to an average depth of about 12 inches consists of a brown or dark-brown loam, underlain to a depth of 30 inches or more by a lighter colored, somewhat heavier loam. Throughout both soil and subsoil there is considerable very fine sand. There is much variation in the soil, often within short distances. Where the drainage conditions are poor the subsoil is apt to be drab-colored. Very often there is no distinct line of demarcation in color between soil and subsoil, the gradation from dark brown at the surface to light brown or yellowish at 30 inches being imperceptible. Usually there are numerous very fine mica flakes in both soil and subsoil. The soil is mellow and easily worked when dry.

The Huntington loam occurs as first bottoms along the Ohio River and its larger tributaries. Its usual topography is flat, with a slight fall toward the stream, and it is never cut or eroded. It is subject to several overflows each year, especially during the spring months, but after planting and during the growing season there is little danger of damage from floods. Both surface and underground drainage are fairly good. Only a few depressions are seen where artificial drainage would be beneficial.

As found along the Ohio River, the Huntington loam consists of a mantle of recent alluvial material spread over the gravel deposits of

the Glacial period. In places the wash from the adjoining hills contributes to its formation, and in general this soil is still in the process of upbuilding, as each overflow deposits a thin layer of loam and organic matter washed from the uplands. As found along the larger tributary streams, it also consists of a deposit of recent alluvial material washed from the hills, but instead of resting upon a deposit of gravel, as along the river, it usually rests upon bed rock.

None of the original hardwood timber is now standing. In the early days the type was in great demand as a general farming soil, being regarded then, as now, as an especially strong soil for corn. The present yield of corn ranges from 50 to 100 bushels, with an average of about 60 or 70 bushels per acre. It is also very well adapted to potatoes, the yield ranging from 75 to 150 bushels per acre. Hay yields from 1 to 2 tons per acre, and this is considered a very desirable soil for this crop as well as for pasture. Sometimes the yield of wheat is fair, but the type is not well adapted to that crop. In favorable seasons it is a productive soil for almost any crop, and because of the frequent overflows it does not need any fertilizer. Nearly all of the type is cleared and under cultivation, but there are a few trees still growing upon it, these being, in the order of their importance, sycamore, beech, elm, walnut, willow, and tulip. It would be an excellent soil for truck were it not subject to overflow.

The following table gives the results of the mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Huntington loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
17681.....	Soil.....	0.0	0.3	0.4	7.9	13.9	54.1	22.7
17682.....	Subsoil.....	.0	.5	.7	4.7	16.2	52.9	24.3

HUNTINGTON FINE SANDY LOAM.

The soil of the Huntington fine sandy loam to an average depth of about 12 inches is a fine sandy loam varying in color from light brown to dark brown and in small areas to nearly black. The subsoil to a depth of 36 inches or more is about the same in texture as the soil, but is lighter colored, although in places it seems to contain nearly as much organic matter as the soil. The organic matter in both soil and subsoil is accounted for by the fact that small fragments of limbs, bark, leaves, and other débris in the flood waters of the Ohio River were deposited with the fine sand.

The soil is easy to plow and cultivate, being mellow and having little tendency to pack or bake. The elevation of the type above low

water in the river is usually less than 30 feet, and consequently a large proportion of it is under water every spring and sometimes later in the year. In the present area the type is found principally upon the small islands of the Ohio River, but it occurs also as long, narrow strips bordering the banks of the river. In these latter locations the type is somewhat higher lying than the area back of it, forming a natural levee. The soil is alluvial in origin and is still in the process of formation.

None of the hardwood timber which originally covered this soil is now standing. Where the soil is accessible and occurs in large areas it is in great demand for the production of corn and truck crops, though in the present area practically none of it is used for extensive trucking. Corn yields on an average about 45 or 50 bushels per acre. Usually wheat is not a safe crop, because of the liability of its being drowned out. Oats do well some years, but are liable to rust. Hay yields on an average from three-fourths ton to 1 ton per acre. It is an excellent soil for Irish potatoes, as was shown farther up the river in the Wheeling area. Cabbage yields about 300 barrels per acre. Besides the above-mentioned crops, asparagus, tomatoes, onions, radishes, and lettuce may also be produced with profit.

Because of its limited extent and its principal occurrence upon rather inaccessible islands in the river, the type has no great influence upon the general agricultural conditions and values of land in the present area. It is of importance, however, because of its especial adaptation to truck crops, its nearness to market, and its apparent inexhaustible productivity, renewed with each overflow of the river. It might be well to adopt some system of intensive trucking upon the islands and arrange for the transportation of the products to the near-by markets by water.

The following table gives the results of mechanical analyses of the soil and subsoil of the Huntington fine sandy loam:

Mechanical analyses of Huntington fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
17685.....	Soil.....	0.0	1.4	8.4	39.6	12.0	30.9	7.6
17686.....	Subsoil.....	.0	.5	6.9	37.4	9.9	35.1	10.4

MEIGS CLAY LOAM.

The soil of Meigs clay loam is rather variable because of its steep location and the influences of the underlying outcropping formations of soft sandy shale and brittle red clayey shales. The soil, however, is usually a silty loam ranging in color from brown to yellowish, with

an average depth of about 8 inches. The subsoil is likewise rather variable in texture, but usually it is a silt loam or loam to a depth of 18 inches and the color is lighter than that of the soil. From 18 to 36 inches it is usually a clay loam or clay varying in color from yellowish to reddish. The red color is always due to the presence of the soft red shales which often outcrop along the steep slopes, and wherever these are present the subsoil has a soapy feel when rubbed between the fingers. Another characteristic of the subsoil is that it nearly always contains some coarse sand. Very often the subsoil rests upon shale and disintegrated rock fragments at a depth varying from 20 inches to 4 feet, their nearness to the surface depending upon the steepness of the slope and the amount of erosion which has taken place. Scattered throughout both soil and subsoil and strewn upon the surface are usually many small soft sandstone and shale fragments, though these, as a rule, are not present in sufficient amounts to interfere with cultivation.

This is one of the most widely distributed types of soil encountered, and is well developed in all parts of the area except in Wetzel County. It is derived from the red shales and soft sandstones and sandy shales of the Dunkard series, and the rate of erosion is approximately equal to that of the weathering. The soil carries a relatively large proportion of loose, incoherent, micaceous sandy material, the product of a partial weathering of the micaceous sandstone fragments below.

The most constant—and, in fact, the only constant—characteristics of this type are its steep, broken topography and content of shale and sandstone fragments, and therefore it really represents more a condition than a type of soil. Except in areas where there is no better farming land, it is not cultivated very extensively, being better adapted to pasture than to cultivated crops. Where cultivated it requires much care to prevent erosion, and even with terracing and contour cultivation the fields are often damaged. On the whole, it is believed that this soil should be kept in permanent pasture or mowing lands, as continued cultivation has in many cases rendered the land worthless even for pasture.

In the northern and northwestern parts of the area the Meigs clay loam occupies the slopes intermediate between the rounded hilltops of Dekalb loam and the slopes at the bottom of the gorges or valleys. In the vicinity of Cameron and St. Joseph, where this is the prevailing type, it occupies the long, steep hillsides and the narrow ridges. Drainage is excessive over most of this type, and as the derivative rocks are usually only 2 to 4 feet from the surface the land is droughty. The bed rock is arranged horizontally, so there is little downward percolation and seepage areas are frequent.

The soil is not adapted to the production of a wide range of crops, although general farm crops are grown on it to a considerable extent in

areas where it is the predominating or the better soil. Hay usually does quite well, as it is not much affected by drought. The fine-earth material seems to be quite productive. It is claimed that with proper attention this soil can be made to give a good bluegrass sod. A few very good bluegrass pastures were seen, and these were obtained by seeding to Kentucky bluegrass and allowing the grass to grow for two, or possibly three, years without interruption. On some portions of the type orchards and vineyards would probably do well.

It is believed that this soil should never be planted to any cultivated crop like corn. Its greatest value lies in its use as permanent pasture. It is recommended that orcharding and grape growing be given a careful trial. The prevalence of the locust suggests that this tree might be grown for ties, poles, and posts.

BROOKE CLAY LOAM.

The soil of the Brooke clay loam is a brown or dark-brown heavy loam or clay loam with an average depth of about 8 inches. The subsoil, to a depth of about 20 inches, is yellowish in color and a little heavier than the soil. Below this to a depth of 3 feet or more the texture remains a heavy clay, but the color often grades gradually from yellowish to drab. Small fragments of gray or bluish-colored limestone and limy shale are often scattered over the surface and through both soil and subsoil.

This type occurs only in a few small patches in the northern part of Marshall County. In Brooke and Ohio counties to the north, as shown in the report on the Wheeling area, this soil is very important not only in extent, but because of its production of profitable farm crops. The limestone formation from which it is largely derived, however, dips along Wheeling Creek, and for that reason very little of the type was met with in the Middlebourne area.

For a fuller description of the type and its especial adaptation see the report on the Wheeling area.

UPSHUR CLAY.

The Upshur clay usually consists of 7 inches of reddish-brown or red clay loam or red clay, underlain to a depth of 36 inches or more by a heavy, tenacious, impervious red clay. There are sometimes small patches in the fields, however, which consist of about 3 inches of gray silt loam, underlain to about 7 inches by a reddish-brown heavy silty clay loam, and below this the usual subsoil.

The type is a very difficult one to till because of its stiff, tenacious character, and is spoken of locally as "cold, wet, late land." In dry weather it has a tendency to bake and is difficult to handle, except in case of the more loamy spots described above, which remain mellow and retain moisture well. In wet weather it forms a deep, sticky

mud in the roads, and in dry weather these roads are very hard and rough until packed and worn down by travel or smoothed over with a road machine.

The Upshur clay is found principally in small, unimportant areas in the southern part of the survey. It usually occupies the tops and slopes of small hills and narrow ridges and sometimes occurs as a band extending around the hill, the rocks from which it is derived apparently extending through the hill horizontally.

The surface is generally steep and hilly, but occasionally it is more level, and in such locations the soil is more loamy and better adapted to general farm crops. The soil has a tendency to wash and gully badly, which is due in part to the impervious nature of the subsoil, which prevents it from absorbing rain water readily.

The Upshur clay is a residual type derived from the soft, marly red shales of the Dunkard series. The red color of the soil is not due to recent oxidation, but to the red color of the original sediment forming the Dunkard shales. There are often nodules of limestone and iron ore included in this formation.

The native vegetation consisted of hardwoods, principally oak, hickory, beech, and maple. Practically all of the soil has been cleared of this original growth, but a great deal of it has been abandoned and allowed to gully and to grow up to brush and briers. Much of it is used for pasture with satisfactory results. When carefully handled it is a fair soil for corn and wheat, but too heavy for potatoes, truck, or fruit. Wheat yields from 10 to 20 bushels per acre and corn from 20 to 50 bushels, but the yield of oats is low.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Upshur clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
17140.....	Soil.....	0.0	0.2	0.4	1.6	1.5	74.7	21.3
17141.....	Subsoil.....	.0	.1	.2	1.1	1.5	50.2	46.2

ROUGH STONY LAND.

In Marshall County the areas of Rough stony land are especially well developed on the hills bordering the Ohio Valley, but in Wetzel and Tyler counties land of this character is of wider distribution and not confined to the river hills.

The surface soil is rather variable, the differences depending upon the steepness of the slope and the character of the sandstone or shale immediately underlying. Usually the surface few inches consists of a

light-brown silt loam or loam containing varying quantities of shale and sandstone fragments. Very often the surface soil rests directly upon fragments of the underlying sandstone or upon the soft marly shale, but usually the underlying formations are farther below the surface, and to a depth of a foot or two there is a loam or a clay loam material intimately mixed with sandstone fragments. In favored places along the slopes there are often small patches of a deeper soil and subsoil.

The Rough stony land is derived from the same formations as Meigs clay loam, and hence the fine-earth material is quite similar. The chief difference is that this type has more unweathered shale and sandstone fragments in it and a steeper and more broken topography, being in the main too steep and stony for profitable general agriculture, though considerable of it is cleared and farmed, especially in localities where there is no better land. Throughout the type there are small areas protected from erosion which have a good soil and can be farmed with reasonable profit, notwithstanding the fact that they are isolated by steep rocky slopes and difficulty is had in removing the crop from the fields. Landslides are very common in the Rough stony land areas, sometimes starting at the top of the hill and stripping everything to bed rock to the bottom of the hill. More often, however, the slides move a few feet or a few rods at most. These naturally produce a rough, uneven slope, with many exposed bare spots, which are often too steep even for a stand of grass.

Rough stony land represents a condition where the rate of erosion is equal to or greater than the rate of weathering, the result of which is that the more resistant sandstone strata often form a succession of conspicuous terraces around the steep slopes. The hard horizontal layers of rock form the steeper parts of the terrace, while the soft sandy shale and marly red shales weather more rapidly and form the more level parts. Narrow level strips along the terraces are often cultivated and the crop yields are moderate. Very fair yields of corn are sometimes obtained upon the steeper slopes for the first year, but they usually are so badly washed and eroded in the second year as to be valueless. By cultivating a narrow strip following the contour of the hill and leaving a narrow strip of sod land above and below, the farmers are often able to grow crops upon a considerable portion of steep, hilly land which it would at first appear to be impossible to cultivate. Most of the type, however, has been left in timber and in many places the timber line represents the boundary between this and other soils.

The Rough stony land is located along the bluffs of the river and along the lower slopes of the narrow V-shaped valleys of the larger streams. The drainage basin of Fishing Creek is practically all occupied by this type. Along the outer bends of the larger streams are

almost vertical bluffs, showing, however, no prominent ledges, except along Fishing Creek, where the massive sandstone outcrops.

Rough stony land, like the Meigs clay loam, is derived from the Dunkard formation, which consists of alternating and comparatively thin beds of sandstone and shales.

SUMMARY.

The Middlebourne area is located in the northwestern part of West Virginia and includes Wetzel, Tyler, and Marshall counties. In a north and south direction the area is about 45 miles long and from east to west from 12 to 32 miles wide. The entire western boundary is formed by the Ohio River.

The topography is irregular, having the appearance of a mountainous country in miniature. The most conspicuous topographic feature is the narrow, gorgelike valley of the Ohio River in the western part, where the hills often rise to 400 feet in height.

The drainage throughout the area is good, and is principally toward the Ohio River. In many places the surface is quite deeply cut, and erosion has been active.

Several branches of the Baltimore and Ohio Railroad afford excellent transportation facilities, and in addition considerable traffic is carried on by way of the Ohio River. Moundsville, New Martinsville, Sistersville, and McMechen, all located on the banks of the Ohio River, are the principal towns.

The climate is mild, neither the winter cold nor the summer heat being extreme. The average length of the growing season is six and one-half to seven months.

About 60 per cent of the total population are farmers, the remaining 40 per cent being engaged in the various industries, chief among which are the oil and gas industries. The farmers are well to do, but on account of the sale of oil and gas rights are not obliged to work their farms on an extensive scale.

Twelve types of soil were recognized, including the Dekalb, Wheeling, and Huntington series, and several minor types.

The Dekalb loam is found principally in the northern half of Marshall County, and is the most important upland soil. It is principally devoted to sheep grazing, but is well suited to orcharding, truck crops, and dairying.

The Dekalb silt loam, although not suited to general farm crops, is an important fruit and truck soil. It is not extensively developed in the survey.

The Wheeling silt loam is one of the most productive soils of the area, and is nearly all cleared and under cultivation. It is well adapted to potatoes, corn, wheat, and hay. Oats are produced to a small extent.

Potatoes yield from 150 to 225 bushels, wheat 15 to 25 bushels, corn 50 to 80 bushels, and hay 1 to 2 tons per acre. Farms consisting of this soil type with some hill land sell for \$80 to \$100 an acre, but those consisting entirely of this soil can not be bought for less than \$150 an acre.

The Wheeling gravelly loam is better adapted to corn than to the general farm crops, the yields averaging about 45 bushels per acre. The yield of wheat ranges from 10 to 25 bushels, while hay yields not more than 1 ton per acre. This soil is well suited to truck, apples, pears, plums, and cherries.

The Tyler silt loam is confined to the second bottoms along the tributary streams of the Ohio River, and is alluvial in origin. When cultivated it yields about 35 bushels of corn, 25 bushels of oats, and from 1 to 1½ tons of hay to the acre. It is not well suited to wheat. On account of lack of drainage it is mostly in pasture. Thorough under-drainage and liberal applications of stable manure would greatly increase the yields of all crops.

The Huntington loam is an especially strong soil for corn, where it lies along the river and larger creeks. On the terraces just above the overflow lands it is well suited to truck crops and fruit, as well as the general farm crops. Corn yields from 50 to 100 bushels, potatoes from 75 to 150 bushels, and hay from 1 to 2 tons per acre.

The Huntington fine sandy loam occupies small islands in the Ohio River or occurs as narrow strips along the river banks. It is particularly well suited to corn and truck crops, although it is seldom found in very large tracts. Corn yields on an average 45 to 50 bushels per acre and hay from three-fourths to 1 ton. Wheat is not safe on this soil, as it is liable to be drowned out. Oats do well some years, but are liable to rust. The type gives good yields of Irish potatoes and cabbage, as well as asparagus, tomatoes, onions, radishes, and lettuce.

Meigs clay loam in point of productivity is a very desirable type for all farm crops. On account of its liability to wash if cultivated it should either be kept in sod or apple orchards should be planted. The growing of locust posts would prove profitable.

The Brooke clay loam is a very valuable soil for general farming, but its area is limited. The Upshur clay occurs in small patches, and is best suited for pasture. When carefully handled it is a fair soil for corn and wheat, but too heavy for potatoes, truck, or fruit. Rough stony land has little agricultural value and should be kept in forest. The growing of locust trees for posts should prove profitable upon this land.

SOIL SURVEY OF MONTGOMERY COUNTY, VIRGINIA.

By R. A. WINSTON and ORA LEE, Jr.

DESCRIPTION OF THE AREA.

Montgomery County is situated in southwest Virginia, in the second tier of counties from the West Virginia line. It comprises an area of 251,776 acres, or about 393 square miles, and is included between 37° and 37° 20' 20'' north latitude and 80° 10' and 80° 40' west

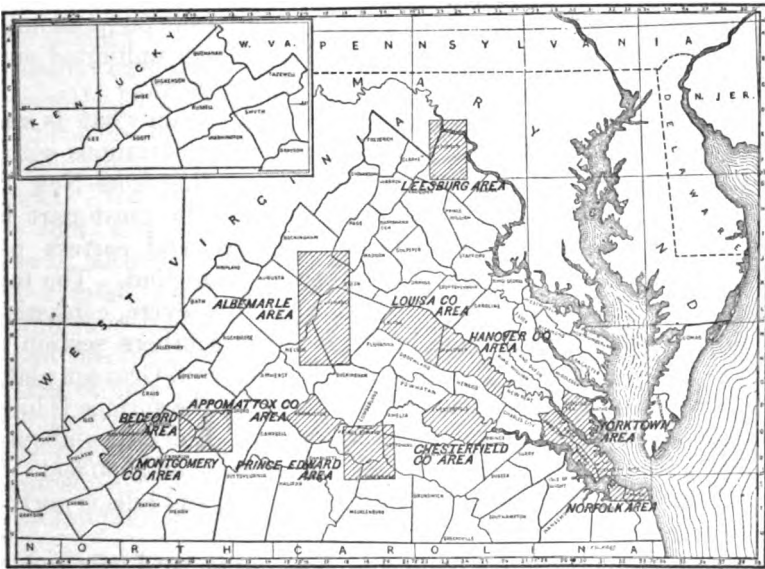


FIG. 5.—Sketch map showing location of the Montgomery County area, Virginia.

longitude. In shape it is roughly a parallelogram, with its longest dimension running northeast and southwest. It is bounded by Giles and Craig counties on the north, by Roanoke and Floyd counties on the east, by Floyd County and Little River on the south, and by Little and New rivers on the west, which rivers in this position constitute the eastern boundary of Pulaski County. Christiansburg, now a thriving town of about 1,000 inhabitants, near the center of the area, was laid out in 1790 and made the county seat, which distinction the town still holds.

While the area surveyed is primarily an agricultural district, the timber of this and adjoining counties supports various lumbering enterprises. Building stone, drawn from the limestone and sandstone formations, is found in abundance. Brickkilns, canning factories, and limekilns are successfully conducted in various sections of the county. Coal mining has been developed to some extent and a good grade of semianthracite coal is mined. The company located at Prices Mountain is the most extensive mining concern. Smaller operations are carried on along Brush Mountain, with the chief output in this section at Prices Forks.

Mineral waters containing sulphur, lithium, magnesium, and arsenic in chemical combination are found in abundance in the county, and many of the springs do a large commercial business on account of the medicinal value of their waters.

The turnpike roads of the county are in fairly good condition, especially the shale roads. There are probably from 30 to 40 miles of macadamized roadways in the area. There is an unlimited supply of road material at hand for use in extending this work.

The greater part of Montgomery County lies within what is known as the "Valley of Southwest Virginia," which is continuous with the great limestone belt, or limestone valley, extending from New York to Alabama. The county is characterized for the most part by a strong surface relief, especially in the northern and eastern parts, where mountain ridges and steep, broken areas abound. The topography of the southern portion is somewhat less severe, consisting of the rolling valley type, which in the extreme southern section runs into the dissected upland known as the Floyd-Carroll-Grayson plateau. The western and central parts of the area where the surface is hilly to rolling have the slightest relief of the county. Elevations above sea level vary from 1,200 to 3,500 feet with an average of 2,250 feet. The general direction of the mountain ranges, ridges, and hills is northeast to southwest.

The two principal drainage lines of the county are Little and New rivers and tributaries in the south and west, respectively, ultimately finding their way into the Gulf of Mexico, and the North and South forks of the Roanoke River with their tributaries, in the east, flowing into the Atlantic. The divide, or watershed, separating these two drainage systems extends across the center of the county in a general north and south direction.

The present population of Montgomery County is made up chiefly of descendants of the first settlers of Virginia, but many homeseekers and investors, attracted by the natural resources of the county, emigrated from the adjoining States. The population of the county is 16,000, of which 13,000 are white, and it is fairly well distributed.

General agriculture, dairying, and cattle and sheep raising being the chief factors in the county's prosperity, the limestone valley lands in the central and western parts of the county, the shale lands in the south, and the bottom or valley lands along the larger rivers and tributaries are the most thickly settled. There are areas in this general division, however, which are so far distant from market centers and so handicapped by the lack of transportation facilities that development has been greatly retarded.

The northern and eastern sections of the county are so broken by mountain ridges which preclude any cultivation that settlement is necessarily confined largely to the narrow valleys. In the eastern part of the county settlement is mainly along the North and South forks of the Roanoke River.

CLIMATE.

The climatic conditions of Montgomery County are quite typical of the middle east mountain section. The winters are usually about four months long, January and February, the coldest months, having a temperature of about 31° F. The summers are ordinarily warm and delightful. During the summer's heat thunderstorms are very frequent. The nights of late spring and early summer are generally quite cold, and the frosts of early May sometimes touch the fruit blossoms, although orchards are seldom injured in this way.

The rainfall is well distributed throughout the year, and especially so throughout the growing season, June, July, and August having the greatest precipitation. Occasionally the late spring rains retard the planting of crops, though the growing season is sufficiently long to overcome the setback.

The following table, compiled from the records of the Weather Bureau station located at Blacksburg, gives the normal monthly and annual temperature and precipitation:

Normal monthly and annual temperature and precipitation.

Month.	Blacksburg.		Month.	Blacksburg.	
	Temper- ature.	Precipi- tation.		Temper- ature.	Precipi- tation.
	° F.	Inches.		° F.	Inches.
January.....	31.3	2.82	August.....	70.1	4.04
February.....	31.1	3.74	September.....	64.3	2.67
March.....	43.3	3.64	October.....	52.9	2.37
April.....	50.1	2.33	November.....	42.4	2.21
May.....	60.6	4.01	December.....	34.8	2.71
June.....	67.7	4.25			
July.....	71.3	5.23	Year.....	51.7	40.02

The table below gives the dates of the first killing frosts in the fall and the last in the spring for the years 1898 to 1903, inclusive, and 1906, and also the average dates for the entire period:

Occurrence of killing frosts.

Year.	Blacksburg.		Year.	Blacksburg.	
	Last in spring.	First in fall.		Last in spring.	First in fall.
1898.....	May 9	Oct. 16	1902.....	Apr. 18	Sept. 14
1899.....	Apr. 19	Sept. 28	1903.....	May 2	Sept. 23
1900.....	May 10	Oct. 18	1906.....	May 11	Oct. 12
1901.....	Apr. 12	Oct. 4	Average.....	Apr. 29	Oct. 4

AGRICULTURE.

The agriculture of Montgomery County before the advent of white settlers, consisted of the growing of small patches of corn and tobacco by the Indians on the easily cultivated and more productive soils of the level areas and depressions adjacent to stream courses.

The first white settlers were homeseekers from the colonies and early immigrants, who cleared small areas of land and devoted them to the cultivation of corn, wheat, buckwheat, tobacco, and various vegetables.

Later, settlers came in from time to time and brought a few domestic animals which they pastured over the immediately surrounding country. The early agriculture is distinctly identified with the growth of tobacco as the principal crop, supplemented with corn, wheat, hay, fruits, and vegetables in sufficient quantities to supply local needs. Tobacco, in the early life of the section, was the principal medium of exchange, as it was throughout Virginia, and continued as such for a long time. The gradual development of the country resulted in a more diversified agriculture, and tobacco, while still important, gradually gave place to other farm products which could be more profitably disposed of. To-day tobacco is of little importance in the county, owing to competition of other sections with soils better suited to this crop. The grazing of sheep and cattle has steadily grown until the county holds an important place in the production of live stock.

According to the census of 1900 the county had 193,987 acres of farm land, of which 111,842 acres were improved. These lands, together with improvements, buildings, implements, machinery, and live stock, represented an investment of \$4,035,087. After deducting the expenditures for farm labor and fertilizers, amounting to \$51,270, from the value of farm products not fed to live stock, amounting to \$533,263, a net surplus of \$481,993, or 11.9 per cent on the capital invested is shown.

The chief crops grown are corn, wheat, oats, clover, and grasses. The following statistics from the 1900 census show the acreage and the yields of the various farm crops:

Acreage and yields of principal crops.

Crops.	Acreage.	Production.
	<i>Acres.</i>	
Corn.....	12,188	291,190 bushels.
Wheat.....	11,930	87,150 bushels.
Oats.....	1,160	19,080 bushels.
Rye.....	668	4,600 bushels.
Tame grasses.....	7,720	8,104 tons.
Clover.....	1,044	998 tons.
Grains cut green for hay.....	301	324 tons.
Tobacco.....	280	161,480 pounds.

Buckwheat, potatoes, millet, Hungarian grasses, vegetables, and orchard and forest products show approximately a value of \$105,000. The general prosperity within the last decade has materially increased land values, much of the limestone valley and shale lands selling for \$75 to \$100 an acre.

Corn and wheat, the chief grain crops, are grown in rotation over the Hagerstown loam and silt loam and the Dekalb silt loam generally, while the alluvial soils of the narrow bottom lands are devoted almost exclusively to corn and hay. Corn has yielded 80 bushels and wheat 30 bushels to the acre without any especial fertilization, but these yields are exceptional.

There is generally some system of crop rotation practiced, which includes a grass crop seeded with wheat and allowed to run for a year or two for the hay product or for grazing purposes.

Some attention has recently been given to the production of tomatoes, beans, and other crops for supplying the various canning factories of the area. Many of the slopes, coves, and valleys seem to be well suited to the growth of excellent grades of tomatoes, which mature without rotting, a difficulty often encountered in the production of this crop in other sections.

Sheep and cattle are profitably raised upon a large scale, as native grasses, including bluegrass and areas seeded in timothy, orchard grass, tall meadow oat-grass, and redbtop, afford excellent pasturage. The abundance of native grasses has been the chief factor in building up this industry. The grazing of cattle is largely confined to the limestone and shale valley lands in the central and western parts of the county, where from 2 to 4 acres are allowed for each animal. The cost of pasturing stock is about as follows: Yearlings, 75 cents; sheep, \$1 to \$1.25; cows, \$1.50; and horses \$2 per head.

The steep, rugged surface of a considerable part of the area precludes tillage. Probably at least one-third of the county should not be cultivated to farm crops. These steeper lands should be seeded

down for pasture. This would prevent much severe erosion, now taking place in cultivated fields. Much of this acreage is devoted to sheep raising, though the industry has not been fully developed and should be extended. The conditions are favorable for sheep raising and the market demands are continually increasing. The production of spring lambs is probably the most profitable side of the industry, although there is ample demand for wool. The breeds best adapted to the conditions and requirements are the Middle Wool Downs, Shropshires, Southdowns, Dorsets, Hampshires, Suffolks, and Oxford, with their crosses.

The rolling valley lands and bottom lands along the larger streams form the most progressive farming sections of the county. Here much improved machinery is being used and the tendency is toward more improved methods of cultivation. While the animal husbandry practiced results in a return of some organic manures to the soil, the amount is entirely inadequate and commercial fertilizers are used extensively for grain, tobacco, and vegetables.

The value of land varies according to the use to which it is suited, location, and condition of improvement. The less rolling limestone soils, the alluvial soils, and portions of the shale soils, have the highest value. These lands vary in price from \$25 to \$100 an acre, while some of the mountainous and very hilly areas range in value from \$5 to \$25.

Some difficulty is experienced in securing farm labor. Wages range from \$15 to \$20 a month, with house, fuel, garden, and pasture free. The bulk of the labor is done by the piece or by the day, the day wage ranging from \$1 to \$1.50. In the busy season of planting and harvesting the laborer receives higher wages. A large proportion of the hired farm labor is negro and is efficient.

Farms are either operated by the owners or by tenants on shares or for a money rental. The share system is more general, and most of the tenanted farms are held in this way. The two most popular forms of share tenancy are known as the "one-third" and the "two-thirds" systems. When the landowner furnishes the land and house only he receives one-third of the crop yields; when he furnishes land, houses, barns, stock, implements, and seed, he receives two-thirds of the produce. Fertilizers are invariably used, and the tenant and landowner share the expense. The average farm is 157.7 acres. Seventy-five per cent of the farms are operated by the owners. On a cash basis, the rent ranges from \$1 to \$3 an acre for the land actually cultivated, but in exceptional cases, where small areas of the strongest lands are leased, the rent may be as high as \$6 to \$8.

It is probable that increased yields could be had by deeper plowing and by following a crop rotation that included every few years a leguminous crop to be plowed under. The addition of organic matter in this way, in connection with barnyard manure, more of which should be saved, would greatly increase the fertility of the soils.

The steeper slopes, where erosion is severe, should be seeded in some deep-rooted grass to prevent washing, and utilized as pasture.

SOILS.

Montgomery County lies chiefly within the great valley region of southwest Virginia. This region, as already stated, is a section of the great limestone valley which has its beginning in New York and, running in a southwest direction, ends in Alabama. On each side of this limestone valley, which is from 5 to 10 miles wide, rise various mountain spurs or ranges composed of the harder or mountain-forming rocks, such as sandstones and conglomerates. These ranges generally extend in a well-defined northeast and southwest direction.

The county is properly called a limestone area, since that formation covers approximately two-thirds of its extent. The upland soils of the area are residual in character and follow more or less closely the underlying geological formations from which they are derived. Local conditions and modifying agencies over smaller areas have contributed to a variety of less important soil types, as has also the intermingling of disintegrated material of two or more formations. The small marginal areas of overflow lands along the courses of the larger streams present the only recent alluvial soil of the county. The various soils and soil conditions, climatic conditions, amount and distribution of rainfall, and the natural productiveness of the limestone soils particularly, combine to render the area well adapted to a diversified agriculture.

Twenty-three types of soil were established in the area, varying from a sandy loam to a clay or clay loam. Some of the shale and sandstone soils often have a low agricultural value, but the limestone areas are invariably productive when properly managed, which is also true of the alluvial soils.

The following table gives the name and the actual and the relative extent of each type:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Rough stony land.....	77,824	30.9	Cumberland loam.....	2,368	0.9
Dekalb stony loam.....	31,872	12.7	Toxaway fine sandy loam.....	2,176	.9
Hagerstown stony loam.....	23,888	11.9	Hagerstown clay loam.....	1,792	.7
Dekalb silt loam.....	25,792	10.2	Paris loam.....	1,536	.6
Hagerstown loam.....	22,400	8.9	Radford loam.....	704	.3
Hagerstown silt loam.....	20,160	8.0	Huntington silt loam.....	576	.2
Pilot loam.....	8,960	3.6	Holston silt loam.....	576	.2
Dekalb fine sandy loam.....	7,552	3.0	Decatur clay loam.....	448	.2
Meadow.....	4,800	1.9	Indian loam.....	384	.1
Cumberland gravelly loam.....	3,840	1.5	Cumberland clay loam.....	192	.1
Pilot gravelly loam.....	2,752	1.1			
Upshur silt loam.....	2,624	1.0	Total.....	251,776	.....
Huntington loam.....	2,560	1.0			

The geological formations underlying the greater portion of the area comprise a vast thickness of sediments ranging in age from Cambrian to Mississippian, or Lower Carboniferous. The extreme southeastern part of the county shows the oldest formations encountered, those of crystalline rocks, such as mica schists, talcose-schists, and quartzose sandstone, of Archean age. The other rocks of the area are chiefly limestones, sandstones, shales, and conglomerates. In common with other areas of the Appalachian Mountain system, these sedimentary rocks, originally laid down in horizontal beds, have been subjected to such an intense compression that they have been greatly folded, twisted, and faulted. Since this compression and resultant uplifts erosion has been active in wearing down the less resisting rocks, like the shale and limestones, much more rapidly than the more resisting rocks, like the sandstones and conglomerates; hence the latter rocks clearly mark the mountain ridges and highest elevations. The variations in topography are indicative of the character of the underlying formation and also of the nature of the overlying soil. Broadly, the soils of the area are influenced by three geological systems, which run in a general line with the Blue Ridge and Appalachian mountains—that is, in the northeast and southwest direction. The most extensive system in the county is the limestone of Cambro-Ordovician time, probably separable into several members. It occurs through the central portion of the county and gives rise to various soils of the Hagerstown series. The purer the limestone the heavier the derivative soil and the smoother the topography. Considerable areas of this limestone show the presence of cherty masses which have resisted weathering and have been left on the surface and in the soil. This cherty material, together with some sandstone fragments, characterizes the Hagerstown stony loam type. The occurrence of this soil is over the well-rounded hills and ridges of the limestone valley. The Hagerstown silt loam and Hagerstown loam are the predominating limestone soils of the more or less rolling valleys and constitute the most valuable soils of the county. In connection with the Hagerstown series were found several small areas of a very red soil which was mapped as Decatur clay loam.

The next extensive system is found both north and south of the valley limestone and is composed of shales, sandy shales, and sandstones ranging in age from Silurian to Lower Carboniferous. From this general division is derived the Dekalb series of soils and the Upshur silt loam. The predominating soil is the Dekalb silt loam, derived from the weathering of shales, sandy shales, and probably some fine-grained sandstone. It occurs more extensively over the south-central portion of the county, where it occupies a topography ranging from more or less rolling to very hilly. The harder sandstones and conglomerates, which preserve the mountain ridges and spurs, give rise to the stony loam and fine sandy loam members of the series.

The other distinct system is found in the extreme southern section of the county and is composed of a series of mica and talcose schists with what seems to be a quartzose sandstone. This is a part of the Floyd County plateau of crystalline rocks of Archean age and, in this county, the derivative soils were classified as Pilot loam and Pilot gravelly loam. The gravelly loam member, containing varying quantities of quartz fragments, occupies the higher elevations.

The alluvial soils of the county are very limited in extent and occur as narrow marginal areas at varying intervals along the courses of the larger streams. This class of soils is divisible into two series, according to the two principal drainage lines of the area, the Little and New rivers in the west and the North and South forks of the Roanoke River in the east. The material occurring along the western streams, which flow through areas underlain by crystalline rocks before reaching Montgomery County, was mapped as the Toxaway fine sandy loam, and the material found along the forks of the Roanoke River, which flow through a region of rocks of different character, was mapped as Huntington loam and Huntington silt loam. The highest terraces along the courses of the Little and New rivers, where waterworn gravel and cobbles are plentiful, represent areas that have in past ages been subjected to river action and present a class of soils composed of ancient alluvial material mantling the residual material, or quite thoroughly mixed with it. Over such areas was mapped a variety of soil types, of which the principal ones are the Cumberland gravelly loam, Cumberland loam, and the Radford loam. The mountainous areas, where cultivation is impossible and where the stone and rock content is high, have been mapped as Rough stony land. The smaller streams of the area, flowing through the narrow valleys, are almost invariably bordered by materials partly alluvial and partly colluvial, which on account of their variable composition it was impossible to separate. Such areas, together with those more typical, have been mapped as Meadow.

HAGERSTOWN STONY LOAM.

This soil consists of a grayish to brownish loam or silt loam 6 to 10 inches deep, underlain to a depth of 24 inches by a reddish-yellow silty clay loam which passes at 30 inches into a yellowish-red to red clay extending to a depth of 36 inches or more. The type is made to include all areas of limestone material having a high stone content or carrying numerous small fragments of cherty limestone and sandstone. In many instances it represents the intermediate conditions between the Rough stony land and the more level and easily cultivated soils. In such cases the soil consists mainly of numerous rock fragments of limestone, cherty masses, and occasionally some sandstone. Outcrops of massive limestone occur at varying intervals over the surface, especially on the slopes and crests of the hills and ridges. In

this position the soil has a very hilly and broken topography, often mountainous, and little of it is capable of cultivation, grazing being its only use. The lower slopes of many of these elevations are made up of a mixed colluvial material, and here limited areas are cultivated with good results. The heavier phases of soil are found in these areas as well as the brighter colored phases, much of the upper material having been transported by the surface waters, leaving the reddish subsoil at or near the surface. The more decided grayish loamy phase is found over the less broken areas where cultivation is more often carried on despite the difficulties arising from the large stone content. These stones are principally fragments of cherty limestone and sandstone. This phase occurs closely associated with the Hagerstown loam, occupying the crests and slopes of many of the higher hills and ridges surrounded by that type.

The soil occurs in areas of varying sizes over the extent of the limestone valley, but more especially over the more broken areas in the east or where the limestone formation adjoins that of the sandstones.

It has a surface ranging from hilly to mountainous. The mountainous and more hilly areas generally support a fair to good grade of hardwood with some pine, while the less mountainous areas are either cultivated or pastured. Much of this class of land could no doubt be successfully utilized in growing apples, as many varieties seem to be well adapted to the conditions. Orchards of limited extent have been grown and fairly good grades of fruit are obtained.

Over the areas where cultivation is feasible good yields of corn and wheat are produced with the aid of fertilizers. On the better areas corn will produce about 35 bushels, wheat from 10 to 20 bushels, and hay from 1 to 2 tons an acre. Grasses are generally seeded with the wheat and allowed to run for two or three years for hay and as pasturage for sheep or cattle. The value of this type varies from \$10 to \$50 an acre.

The following table gives the average results of mechanical analyses of samples of soil and subsoil of the Hagerstown stony loam:

Mechanical analyses of Hagerstown stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17562, 17564.....	Soil.....	1.1	3.8	3.4	9.0	2.3	60.5	11.3
17563, 17565.....	Subsoil.....	.4	1.5	2.6	6.6	5.3	35.1	48.1

HAGERSTOWN LOAM.

The soil of the Hagerstown loam is a gray to a light grayish-brown loam 8 to 10 inches deep, underlain by a yellowish clay loam which passes at about 24 inches into a stiff, heavy, yellowish-red to red clay

extending to a depth of 3 feet or more. The soil contains generally much silt, and the sand content is of finer grades. The more level areas and lower slopes and depressions in the valley lands are gray in color and have the deepest surface soil. Much of the fine earth of the upper soil has been washed down to these positions by the surface waters. The crests and upper slopes, and occasionally a more level area, will show the yellowish-gray to grayish-brown soil which often approaches a clay loam. In these instances erosion has transported enough of the sands and silt to bring the remaining surface material under the influence of the yellowish-red subsoil. In a great many cases the correlation of such areas was an arbitrary matter. Over many of the ridges and hills were found varying quantities of cherty material, which remains from the weathering of the impure massive limestone and fragments of sandstone. These ridges rise irregularly throughout the area occupied by this soil and generally extend in the direction of the longer axis of the valley. The percentage of rock fragments is often sufficiently high to interfere with cultivation. The soil is broken with many small areas of the Hagerstown stony loam. The subsoil is uniform throughout the type.

The Hagerstown loam is found in many irregular areas throughout the limestone valley. A few small bodies were mapped in the northeast part of the county between Brush and Paris mountains. The most extensive occurrence begins on the divide a few miles north of Blacksburg and reaches, as a narrow strip generally parallel with the divide, to Christiansburg, where it broadens out and extends in a westerly direction to New River, broken, however, by many small areas of other soil types. The soil occupies approximately 35 square miles and is considered good farm land, easily cultivated and improved.

The general topography is gently rolling to rolling and the drainage is everywhere excellent. The more hilly areas are inclined to wash, but terracing or seeding in grass will prevent serious damage from this source.

This soil is derived from the weathering of a more or less pure limestone of the Shenandoah formation. The less pure strata give rise to the cherty material so generally found on the ridges. There occur quite often seams of calcareous shales and sandy shales which influence the immediate soil, but such areas are too small to represent on a map of the scale used. Where the soil adjoins the shale lands to the south there is a gradation zone showing an intermingling of the two formations, but with the limestone material predominating.

Corn, wheat, and grass are the chief farm crops, and good yields are obtained. Corn will yield from 30 to 60 bushels, wheat from 15 to 25 bushels, and hay from 1 to 2½ tons to the acre, the lower lying areas and depressions being probably better suited to grass and corn. The soil seems to be especially adapted to certain varieties of apples,

including the York Imperial, Ben Davis, Smith Cider, Yellow Transparent, Peck's Pleasant, and Grimes Golden, named in order of their apparent adaptability to soil and climatic conditions. Tomatoes and beans do especially well. They are grown in large quantities for the various canning factories of the area and are very profitable. Many of the hills and ridges in this soil, which support a hardy growth of nutritious grasses, are used almost exclusively for cattle and sheep grazing. The practice of seeding the steeper slopes to grass is probably the best method of utilizing such areas. The value of the soil varies from \$30 to \$100 an acre, according to location and local conditions.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Hagerstown loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17548.....	Soil.....	0.6	4.5	6.3	17.1	4.3	54.6	12.9
17549.....	Subsoil.....	.4	1.1	2.6	6.7	6.4	30.9	51.1

HAGERSTOWN SILT LOAM.

The soil of the Hagerstown silt loam is a gray or occasionally brownish-gray silt loam, often containing a low percentage of fine sand and over some of the well-rounded and gently rolling hills a percentage of very small, well-weathered calcareous shale fragments. The subsoil is a yellowish to reddish-yellow clay loam, passing at about 24 inches into a stiff, heavy, yellowish-red clay, which extends to a depth of 3 feet or more. The depth of this clay is uncertain, as washes and road cuts will often show it to be 15 feet deep. Narrow seams of calcareous shales are found on the crests and slopes of some of the higher, well-rounded hills and ridges in the more or less rolling valley lands, and the subsoil contains some disintegrated shaly fragments. In the more level areas or valley depressions the surface soil has a characteristic gray to light-gray color, and reaches its greatest depth. It may, however, in the lower depressions along the courses of the small streams where drainage is poor, show small spots where the color of the soil ranges from dark gray to black and of the subsoil from gray to light gray. The presence of an excess of moisture no doubt produces these variations in color. The grayish brown phase is invariably found on the crests or slopes, where erosion has influenced an intermingling of the red clays beneath, giving a soil that approaches in texture a clay loam. These areas are usually very small, but when large enough were mapped as the Hagerstown clay loam. The type as a whole is one of the strongest and most valuable

for general farming, fruit growing, and grazing. Cultivation is easy, and a good tilth is readily maintained.

The only extensive occurrence of this soil is found in the northwest quarter of the county in two uniform areas—one in a broad, rolling limestone valley to the north of Prices Mountain and west of the divide near Blacksburg, the other in a somewhat more rolling country south of Prices Mountain and west of the divide near Christiansburg. Prices Mountain, a Lower Carboniferous formation of sandstones and shales, rises in the midst of this limestone valley. The two areas extend in a rather uniform breadth almost to New River. The topography of the type is more or less rolling, often very gently rolling, but the relief is always sufficient to afford excellent drainage without producing erosion.

The Hagerstown silt loam is derived from the weathering of the purer grades of the Shenandoah or Valley limestone of Cambro-Ordovician age, with cherty areas of impure material. The limestone rock has weathered more completely and to a greater depth than in the other soils of the area, and this has resulted in a smooth topography with less active erosion. The lower depressions will invariably show, however, a deeper surface soil than the crests and slopes of the surrounding elevations.

The soil forms a broad expanse of excellent farming land, ranging in value from \$75 to \$125 an acre. Corn, wheat, and hay are the chief crops, while various fruits and vegetables are produced for local consumption. Tomatoes seem to do exceptionally well, and many small areas are planted to supply the canneries. Corn produces from 35 to 50 bushels, wheat from 15 to 30 bushels, and hay from 1 to 3 tons to the acre. The fields are allowed to remain in grass for a year or two as pasturage for cattle, the grazing industry being extensive in this section. Some of the lower lying areas along the streams are devoted exclusively to the production of hay. Commercial fertilizers are advantageously used. The application of stable manure and a rotation, including a leguminous crop to be plowed under, will insure a continuation of good crop yields.

The greater part of the type is under cultivation or in pasture, with a few wooded areas supporting a good grade of hardwood.

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Hagerstown silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17542, 17544.....	Soil.....	1.2	3.1	2.0	7.7	4.9	71.9	9.5
17543, 17545.....	Subsoil.....	.4	1.3	1.0	4.1	11.0	41.1	40.3

HAGERSTOWN CLAY LOAM.

The Hagerstown clay loam consists of 6 to 8 inches of a yellowish-red to brownish clay loam, carrying often small fragments of cherty and shaly limestone. The subsoil is a stiff yellowish-red clay. The more loamy phase of the surface soil is of a silty nature, as the type is closely related to the Hagerstown silt loam. It is developed in a single limited area in the western part of the county south of Prices Mountain. It occupies the crests and slopes of some of the hills or ridges, where erosion has carried away most of the silty surface soil. The drainage is everywhere excellent. The type is a good soil for general farming, though less easily handled than the lighter textured limestone soils.

The Hagerstown clay loam, like the Hagerstown silt loam, is derived from the Shenandoah limestone, its occurrence being due to erosion, which has brought the underlying subsoil near the surface. The soil at present is not in the best condition, but could be improved by careful tillage to prevent washing and to produce a friable surface soil. The addition of organic matter through the use of stable manures or the plowing under of cowpeas, clover, or other leguminous crop would have a very beneficial effect on the texture and would improve the yields.

DECATUR CLAY LOAM.

The soil of the Decatur clay loam to a depth of 6 to 10 inches is a brown to reddish-brown clay loam, underlain by a heavy reddish-brown to red clay loam quickly passing into a heavy, stiff, deep-red clay. The surface soil is occasionally a heavy loam or silty loam where the surface does not allow severe erosion, and it has the greatest depth in such areas. In the more hilly to mountainous areas, where the relief is severe, the surface soil has a redder color and is shallower. The subsoil, into which the soil passes gradually, is at all times a heavy dark-red clay. Where cultivation is feasible this type of soil is easily handled and a good tilth is obtained. As this soil is heavy, care must be taken to plow it in the proper moisture condition.

The soil is not at all extensively developed, being mapped only in two small areas, one about 7 miles southwest of Christiansburg, the other near Shawsville. In the former position it has an easy rolling topography, while in the latter the surface is very hilly, merging into rolling valley lands immediately north of Shawsville. Drainage is good throughout, though on the steeper slopes erosion is apt to be severe.

The soil is derived from the weathering of the massive Shenandoah limestone. A few fragments of unweathered rock indicate that the limestone contained some cherty material, though in much smaller quantities than is general. Near the Roanoke River around Shawsville the surface soil carries some rounded, waterworn cobbles of flint and sandstone.

The areas of this soil permitting cultivation are chiefly devoted to the growing of corn, wheat, and grasses. When seeded to grass the fields are used for a year or two as pasture before being replanted in corn or wheat. Good yields are obtained and the type is regarded as a strong soil. Corn will yield from 40 to 60 bushels, wheat from 15 to 25 bushels, and hay from 1 to 2½ tons to the acre. Commercial fertilizers insure increased yields of wheat and corn, though their use is not general. The value of land of this type of soil averages about \$60 an acre, the mountainous slopes having considerably lower value, while some small areas may command \$100 an acre where well located and well improved.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Decatur clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17527.....	Soil.....	1.8	5.6	2.8	8.4	3.3	54.0	23.2
17528.....	Subsoil.....	3.8	4.4	2.1	5.5	7.9	50.7	25.8

DEKALB STONY LOAM.

The Dekalb stony loam, to a depth of 4 to 10 inches, is a gray to yellowish-gray loam to silty loam, underlain by a more decided yellow clay loam to clay subsoil. The surface soil may in places contain a sufficiently large quantity of sand to make it a fine sandy loam or a light-textured loam, and everywhere there is a high content of sandstone fragments of various sizes and generally some fragments of conglomerate. This conglomerate, while found more conspicuously in the southern portion of the county around Pilot Mountain, may be seen in limited quantities over most of the high mountainous ridges. This soil is underlain by sandstones, sandy shales, conglomerates, and gray to brownish shales, outcrops and ledges of which may often be seen on the crests and slopes of the elevations. The fine earth of the type has not been used as a basis for separation and the Dekalb stony loam will include areas ranging from a clay loam to a sandy loam. The general roughness of the areas and the high stone content are the controlling factors in the classification. Cultivation is in general impracticable and often impossible, either the underlying rock formation being too near the surface or the percentage of rock fragments too high. Cultivation is limited to a few of the more level areas and valleylike depressions, or to some less steep and stony slopes, but even here farming is carried on with more or less difficulty and with little profit. The greater part of the deforested areas is utilized as pasture for sheep, while the timbered stretches of the hills and mountains are valued chiefly for their chestnut and chestnut oak timber, which is of moderate growth.

The type is mapped extensively in the northwest, east-central, and southern sections of the county, where occur the Paleozoic shales, sandstones, sandy calcareous shales, and conglomerates. These formations represent the mountain-forming rocks of the area and the topography as a whole is very rough and broken. The soil in the narrow valleys or more level stretches adjacent to the base of the mountain slopes, represents, no doubt, much material that has worked down from the elevations. Drainage is everywhere good.

The chief crops are corn and wheat, with small patches of buckwheat and vegetables, fair yields of which are obtained. Sheep grazing is extensively practiced in the hilly and less mountainous areas which support a fair to good growth of native grasses. No doubt much of the Dekalb stony loam now of little agricultural value could be profitably devoted to the production of suitable varieties of apples. Many small orchards now in bearing are giving satisfactory returns.

DEKALB FINE SANDY LOAM.

The Dekalb fine sandy loam consists of a gray to yellowish-gray fine sandy loam from 9 to 16 inches deep, underlain by a yellowish to reddish-yellow compact fine sandy loam, sometimes passing into a friable yellowish clay occasionally streaked with red. The surface soil generally carries fragments of sandstone, especially on the slopes of the mountains. These fragments may occur throughout the soil and subsoil, though they are more numerous on the surface.

The soil occurs in the northern part of the county at varying intervals along Brush Mountain, in the narrow valley between Brush and Gap mountains, and in the eastern part of the area on the eastern slope of Paris Mountain. The slopes extend in a rather easy incline from the base to the crests. This topographic feature, together with the thick timber growth of chestnut, oak, and pine, prevents any very serious erosion, and the disintegrated material accumulates to a depth of several feet. On the eastern slope of Brush Mountain, where the largest area of the type occurs, the rotten broken sandstone is often encountered at a depth of less than 3 feet. The soil in the Paris Mountain area is probably more loamy than on Brush Mountain, and contains a slightly higher percentage of silt. Here a yellowish subsoil often mottled with reddish streaks occurs. Little of the type is under cultivation, although much of it could be cleared and utilized profitably for agricultural purposes.

The soil is residual in origin, derived from the disintegration of sandstone and shale rocks, which belong to the Lower Carboniferous.

The topographic relief is generally sufficient to insure good drainage, though small areas were encountered in the valleys with a rather level topography. Many of these areas are under cultivation

and fair yields are obtained. The soil is very easily cultivated, and responds readily to fertilization, but yields only fair crops. Corn will average from 12 to 20 bushels and wheat from 5 to 12 bushels to the acre. It is probable that the type on the southern and south-eastern slopes is far better adapted to fruits and vegetables than to the general farm crops. The soil is very loose and light and the incorporation of organic matter with the fine earth is essential.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Dekalb fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17531.....	Soil.....	2.8	8.1	9.4	32.5	7.0	32.6	8.0
17532.....	Subsoil.....	1.4	3.9	0.7	19.9	5.7	33.0	29.5

DEKALB SILT LOAM.

The soil of the Dekalb silt loam, to a depth of 10 to 15 inches, is a gray to pale yellowish-gray silt loam, carrying a small percentage of fine sand and numerous small fragments of red and yellow shales, sandy shales, and sandstones. These fragments from the underlying formations are generally pretty well weathered, especially at or near the surface. The subsoil, from 14 to 26 inches, is a yellowish silty loam to clay loam, showing little tendency to plasticity and stickiness, and having a percentage of small shaly fragments. At 26 inches the material passes into a rather heavy yellowish clay which extends to a depth of 3 feet or more. The subsoil has not always so great a depth and sometimes passes into the underlying rock formation at from 20 to 30 inches. In the more hilly or ridgy areas, the silt loam or clay loam generally grades into a rotten shale or fine-grained sandstone, which can be bored into for a few inches, when a less disintegrated material is encountered. Outcrops of the formation often appear on the crests and slopes of the hills and ridges, and occasionally the fine earth of the type has a depth of only a few inches with the unweathered rock material just beneath. Many of the ridges are almost bare and a continuous outcrop of shaly rock marks their crests. The soil, however, increases in depth down the slopes and is deepest in the more level areas or valleylike depressions surrounding the hills and ridges. This greater depth is due to wash of material from the higher land. Such areas are usually more productive. Sometimes the quantity of shale fragments becomes so great that the type approaches a shale loam, but areas of this character are of small extent. The varying color of these

shales, ranging from yellowish to reddish-brown to purplish-red, locally influences the color of the soil, but the predominating color is yellow and such areas were included with the Dekalb silt loam rather than with the Upshur silt loam.

The Dekalb silt loam is most extensively developed in the southwest part of the county, though many small areas occur at irregular intervals throughout the central part. The largest area is found southwest of Christiansburg, between the limestone belt on the north and Pilot Mountain on the south, where the less resistant shales have resulted in a hilly or more or less rolling topography. Many smaller areas occur in proximity to the limestone soils. In fact the soil along the lower slopes of many of the well-rounded hills and ridges is broken by outcrops of crystalline limestone and contains an admixture of material derived from this formation. In such instances erosion has worn away the later shale formation and exposed the underlying limestone, while the crests and higher slopes still retain a mantle of the carboniferous material which may be several feet thick. Such detail conditions could not be shown in the map. In the northeast part of the county between Paris Mountain and Fort Lewis Mountain there are a few square miles of this type.

The Dekalb silt loam is derived from the weathering of yellow to gray shales, sandy shales, and fine-grained sandstones chiefly of Paleozoic age, ranging probably from Silurian to Lower Carboniferous. The shale formations vary in color from a yellowish or reddish to dark gray, while the sandstones are generally of a yellowish-gray color.

As a rule the topography varies from more or less rolling to hilly and the drainage is everywhere excellent. Some of the more accentuated hilly areas are inclined to suffer from erosion. The softer shales, as southwest of Christiansburg, have weathered more easily and the topography in such cases is smoother.

The Dekalb silt loam has good tilth, responds readily to fertilization, and crop yields are generally good. The rougher areas where cultivation is less feasible are used as pasture for cattle and sheep. These areas support a good growth of native grasses and sheep raising, especially, is an extensive industry over the hilly areas. Of the staple farm crops, corn, wheat, and hay are most important. Corn will produce, with the application of some commercial fertilizers, an average of 20 to 35 bushels, wheat from 12 to 20 bushels, and hay from 1 to 2 tons to the acre. The lower lying areas are more productive than the average uplands and corn makes better yields, especially on the areas adjacent to streams. Increased yields could no doubt be secured by the application of organic matter, either in the shape of stable manure or by plowing under green manuring crops, preferably some of the legumes, as cowpeas, clover, or vetch.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Dekalb silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17535.....	Soil.....	2.5	2.1	0.7	2.3	2.8	80.4	9.2
17536.....	Subsoil.....	2.3	2.3	.9	2.1	6.3	60.2	25.5

PILOT GRAVELLY LOAM.

The soil of the Pilot gravelly loam is a yellowish-gray loam containing a high percentage of small and often large fragments of white quartz. The subsoil to a depth of 36 inches is a pale yellowish to yellowish-red clay loam to clay having a greasy feel. The fine earth is quite similar to that of the Pilot loam. The type occurs in connection with the Pilot loam, occupying some of the crests or slopes of some of the hills and ridges. The soil, in many cases, can not be cultivated on account of large quantities of gravel and stone, but when cultivation is feasible fair to good yields are obtained.

The Pilot gravelly loam is not an extensive soil and occurs only in the southeastern part of the county. It is derived, like the Pilot loam, from crystalline rock of Archean age. The quartz, originally occurring in veins, has been left on the surface and in the soil during the processes of weathering and erosion. The uncleared areas support a fair growth of hardwood and pine, which is being marketed in large quantities.

The type has a value of \$10 to \$35 an acre, depending on location and condition of improvement.

The following table gives the results of mechanical analyses of the fine earth of both the soil and subsoil of this type:

Mechanical analyses of Pilot gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17568.....	Soil.....	4.3	12.1	6.0	12.9	8.8	39.8	15.6
17569.....	Subsoil.....	3.4	7.6	3.9	8.4	12.1	34.1	30.0

PILOT LOAM.

The soil of the Pilot loam consists of a yellowish-gray to yellowish-brown loam 8 to 12 inches deep, containing a small percentage of coarse sand and some very small fragments of schist and quartz rock. The subsoil is a yellowish-red to brownish clay loam grading into a heavy red clay, not very tenacious or plastic, containing some

small subangular gravel, some sand, and having a slick, greasy feel. The gray phase of the type is found over the areas where erosion has been less effective, while the brownish phase is found generally on the crests or slopes of the elevations adjacent to stream courses or valleys. Here erosion has removed much of the surface soil and brought the subsoil sufficiently near the surface to influence the color.

The topography of this soil ranges from hilly to gently rolling, with some small areas quite level and others quite steep and broken. Drainage is at all times good.

The Pilot loam occurs in the southern and southeastern parts of the county south of Pilot Mountain and extends to the Floyd County line. It covers an area of approximately 14 square miles. Occurring as it does over a part of the Floyd-Carroll-Grayson plateau, the soil is derived from the weathering of crystalline rocks—mica schists, talcose schists, and coarse-grained quartzose sandstone, belonging to Archean age and constituting the oldest geological system of the county. In the process of soil formation much rock has been left on the surface.

The soil is comparatively easy to handle, and the yields range from fair to good. It is cultivated in corn and wheat principally, corn producing from 30 to 50 bushels and wheat from 10 to 20 bushels to the acre. Oats and grasses are grown as forage crops and average yields are obtained. This soil responds quite readily to fertilizers and is capable of decided improvement. The adoption of a systematic crop rotation, including a leguminous crop to be plowed under, would substantially increase its productiveness and less commercial fertilizer would be needed. The type has a value of \$10 to \$50 an acre.

The following table gives the average results of mechanical analyses of fine-earth samples of this type:

Mechanical analyses of Pilot loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17564, 17566.....	Soil.....	3.8	16.2	8.1	15.5	8.1	35.1	13.1
17565, 17567.....	Subsoil.....	3.5	10.5	5.5	10.3	6.9	27.3	35.9

UPSHUR SILT LOAM.

The soil of the Upshur silt loam to a depth of 8 to 15 inches is a purplish-red to purplish-gray or Indian red silt loam, containing a high percentage of small red-shale fragments which have been weathered from the underlying formation. The sand content of the soil is low and consists of the finer grades. The subsoil is a heavy, purplish-red, compact silt loam grading into a reddish-brown silty clay and passing at lower depths into decomposing shales of a reddish to yellowish

color. The percentage of rotten shale fragments increases with depth and generally the type passes at about 24 to 36 inches into massive rotten shale. In both soil and subsoil are generally found varying quantities of yellow-colored shales, though not enough to change the characteristic red color.

The Upshur silt loam occupies almost invariably well-rounded hills and ridges, though the surface may be steep and suitable only for grazing. Local areas in rougher sections contain so much broken sandstone that they are of little value save for the timber. The character of the surface promotes good drainage.

This soil is derived from the disintegration and weathering of red sandstones, red shales, and red sandy shales of Paleozoic age. The red to purplish-red color of the soil distinguishes it from the Dekalb silt loam. The separation of the two types in the field is often difficult because of the intermixture of red and yellow materials, and in such cases the boundary lines were drawn somewhat arbitrarily.

The native timber growth is a more or less scrubby hardwood, with some pine. The cultivated areas are used for wheat, corn, and hay, and fair to good yields are obtained. The soil has a good tilth, is easily handled, and responds readily to fertilization. Commercial fertilizers are used with good results. The application of stable manure would tend to a more permanent improvement, and where manure is not available some crop rotation, including a leguminous crop to be plowed under, will prove valuable. Corn will average from 12 to 25 bushels, wheat from 10 to 20 bushels, and hay from 1 to 2 tons to the acre. The type is not extensively developed and is of little importance in the agriculture of the county.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Upshur silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17581, 17583	Soil	1.7	3.7	1.4	8.1	11.5	59.2	13.8
17582, 17584	Subsoil	1.8	8.4	3.6	6.9	6.1	48.6	24.3

ROUGH STONY LAND.

The Rough stony land includes the various areas of the county which are either too rocky or stony, or too rough and broken, for agriculture. The fine earth of the Rough stony land in the mountainous areas composed of the harder rocks, like the sandstones, is a sandy loam, while in other mountainous areas, especially in the east, the interstitial material is mainly clay. This latter phase of the Rough stony land is derived for the most part from crystalline limestone,

bowlders, outcrops, and ledges of which form the crests and slopes of the high hills and ridges. The possibility of agriculture was the basis for the separation in these areas. Occasional patches of corn, buckwheat, or vegetables may be seen on the mountain slopes, especially on the lower slopes where the soil has accumulated as wash from the higher elevations.

The Rough stony land is found in the northern and eastern parts of the county, principally, over the mountain ranges and highest hills. Gap, Brush, Prices, Paris, Fort Lewis, Poverty, and Pilot mountain ranges give rise to more or less extensive areas. The eastern part of the county, including the territory embraced by the Poverty Mountains, is especially rough and broken.

The Rough stony land is valuable mainly for its timber growth of hardwood and pine, and considerable lumbering is being carried on. No doubt many areas of this type could be utilized very profitably in the growing of apples. Sheep are grazed over limited areas which show a fair to good growth of native grasses.

CUMBERLAND GRAVELLY LOAM.

The soil of the Cumberland gravelly loam consists of 6 to 12 inches of a grayish to yellowish-gray loam, often approaching a sandy loam in texture, though the content of silt is always high. The subsoil is a heavy yellowish loam to clay loam, which generally grades into a heavy material, becoming redder as the depth increases, and at 30 to 36 inches passing into a yellowish-red to red clay. There is generally a slight sand content in the upper subsoil. The percentage of rounded pebbles and cobbles on the surface and in the soil is generally high. These pebbles and cobbles vary in size from one-eighth inch to 3 inches in diameter.

The soil is found in small areas scattered along the courses of the larger streams. It occurs in some of the old river terraces in connection with the Cumberland loam, and is of the same origin and manner of formation. It forms the crests or slopes of some of the hills and ridges, and its drainage is always good.

The better areas are devoted to the cultivation of the usual farm crops, corn, wheat, oats, and grass. The yields are fairly good. As the area of this soil is limited it has little agricultural importance.

CUMBERLAND LOAM.

The soil of the Cumberland loam is a grayish to yellowish-gray loam, tending in some places to a silty or sandy loam, 10 inches deep, carrying generally a small percentage of rounded, waterworn gravel and traces of minute mica flakes. The subsoil is a heavy yellowish loam, or clay loam, becoming heavier in texture and structure with depth, passing at about 24 inches into a yellowish-red to red clay.

This clay is not especially tenacious, and, like the surface soil, contains some mica flakes. Along the slopes of the elevations as they grade to the river valley proper is found the brighter-colored phase of the type. In this position the drainage waters have removed much of the soil, and the subsoil lies near the surface. The subsoil also, in this position, being often exposed through the agencies of erosion, has a much redder color, owing, no doubt, to freer aeration and more perfect oxidation. In some cases around Radford the subsoil is very red.

The Cumberland loam is found along the courses of Little and New rivers, occupying the most elevated and oldest of the river terraces. It has a topography ranging from gently rolling to very hilly, with excellent drainage, except in a few instances. The material was laid down by the rivers during a remote period and its origin is sometimes quite obscure, though the presence of rounded, waterworn gravel and cobbles establishes the action of running water at some stage of its formation. Erosion during the time in which the river has worn down its valley to the present level has removed much of the original alluvial material of these old terraces to lower elevations, and what remains has become more or less intimately mixed with residual material from the underlying limestone formations. The surface soil, where erosion has not been active, is unquestionably a material of ancient alluvial origin, while the subsoil is derived in situ from the underlying rock. On the slopes around Radford where the pronounced red subsoil occurs the ancient alluvial soil has been almost entirely removed.

The soil is used chiefly for corn and wheat, with small patches of vegetables and other garden crops for home consumption. Grasses are also grown and cut for hay or utilized as pasture for stock. The type has a value of \$10 to \$100 an acre, depending mainly on its position.

The following table gives the results of mechanical analyses of the fine earth of the soil and the subsoil of this type:

Mechanical analyses of Cumberland loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17572.....	Soil.....	1.0	4.0	2.7	12.4	9.9	56.5	13.4
17573.....	Subsoil.....	.6	2.0	1.7	8.1	11.8	35.2	40.9

RADFORD LOAM.

The soil of the Radford loam, to a depth of from 10 to 24 inches, is a gray to brownish-gray loam, containing a relatively high percentage of silt and some mica flakes. The subsoil to 24 inches is a

heavy yellowish loam to clay loam, showing little tenacity and containing also minute mica flakes. Below 24 inches the material grades into a yellowish-red clay loam to clay, passing at lower depths into a reddish friable clay. The soil is quite easily tilled.

The type occurs as a second-bottom soil between the oldest river terraces and the most recent bottoms. The topography is level to gently rolling and drainage is good, except over the more level areas, where it is sluggish. As the soil is more or less open-textured, better drainage could be effected by open ditches.

The soil represents an intermingling of alluvial, colluvial, and residual material. The upper soil to a depth of 1 to 2 feet is composed of alluvial material which was laid down at an early period during overflow, and of transported material, or the wash from the surrounding elevations through the action of the surface waters. The subsoil is for the most part unquestionably residual. On the swells is found the lightest colored phase of surface soil, and the mixed condition of the transported and residual materials is most evident. The lower depressions have the darkest colored soil, owing no doubt to the presence of much organic matter and to the wash from the adjacent elevations.

The general farm crops of corn, wheat, oats, and hay are grown profitably. The lower, moister areas are usually devoted to corn, which yields from 40 to 75 bushels to the acre. Some of the soil is continuously used for hay and as pasture for stock. Careful and deep tillage, systematic crop rotation, and the addition of organic matter will maintain the productiveness of this type of soil. Much of this soil type has a value of \$25 to \$100 an acre, according to location and condition of improvement.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Radford loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17562.....	Soil.....	0.2	3.0	3.3	23.0	15.7	42.5	11.6
17563.....	Subsoil.....	.7	2.0	3.3	19.6	18.2	32.1	23.9

HUNTINGTON SILT LOAM.

The soil of the Huntington silt loam is a light-gray silt loam 12 inches deep, passing quite abruptly into a mottled light-gray and reddish silt loam, which extends to a depth of 24 inches. This material grades into a reddish-yellow clay loam, which passes in turn at about 30 inches into a yellowish-red clay, extending to a depth of 3 feet or more. The slight depressions occurring over the type will

show a slightly darker colored surface soil, owing no doubt to the presence of accumulated organic matter. The soil is cultivated with some difficulty on account of poor drainage, but when handled under proper moisture conditions good tilth is secured.

The Huntington silt loam is found in the second bottom chiefly along the South Fork of the Roanoke River below Shawsville. This bottom is but slightly higher than the first bottom, where the Huntington loam is the soil type.

The topography is comparatively level and drainage is sometimes inadequate. Open ditches or tiled drains would relieve this condition and obviate the chief difficulty in cultivation—excess of moisture.

The Huntington silt loam is no doubt formed from the intermingling of the wash material from the adjacent slopes and the alluvial deposits of the Roanoke River. It is a less recent soil than the Huntington loam, though one of the more recent soils of the area. Its occurrence is not at all extensive. It lies midway between the oldest river terraces and the recent bottom lands immediately along the channel.

The type is productive and yields are, as a rule, good. Corn, wheat, and hay are the principal crops grown, corn yielding from 40 to 60 bushels, wheat from 12 to 20 bushels, and hay from 1 to 2½ tons to the acre. Deeper tillage, with some leguminous crop to be plowed under and proper attention to drainage, would result in increased yields. The type has a value of \$60 to \$75 an acre.

Below are the results of mechanical analyses of samples of soil and subsoil:

Mechanical analyses of Huntington silt loam.

Number.	Description.	Fine. gravel.	Coarse. sand.	Medium. sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17577.....	Soil.....	1.4	4.0	1.4	4.4	7.2	71.4	9.8
17578.....	Subsoil.....	.2	.9	.8	6.2	7.8	48.3	34.9

HUNTINGTON LOAM.

The Huntington loam consists of a brown loam, often approaching a sandy loam, 18 inches deep, underlain to a depth of 36 inches or more by a compact, rather heavy loam. The entire soil section of 3 feet often shows no appreciable change either in color or texture. Occasional areas approximate a sand, and there may also be found small areas containing a percentage of rounded waterworn pebbles and small angular fragments of rock, transported from the adjacent elevations. The soil in general is comparatively easy to work.

The Huntington loam occurs chiefly along the courses of the North and South forks of the Roanoke River at irregular intervals as narrow marginal strips, and there are a few areas along the courses of some of the smaller streams in the eastern part of the county.

There is a very limited development of the alluvial soils in the area as a whole, this type being confined to the very narrow valleys of the Roanoke forks.

The surface of this soil is nearly level, though the slope is seldom insufficient for good drainage. Like most first-bottom lands, it includes an occasional depression, where drainage is sluggish. Open ditches are all that is necessary to drain these areas, as the soil is quite open textured and allows free movement of water.

The Huntington loam is of a rather heterogeneous nature and consists of both alluvial and colluvial material. From the steep slopes flanking the narrow valley on each side, material has been washed to the lower lying land, where it has become mixed with sands, silts, and clays deposited by the streams. The heavier phase of the type is generally found in the depressions, where the surface soil is darker colored.

This type of soil, where carefully cultivated, yields well, corn being the chief crop, producing from 40 to 75 bushels to the acre. Much of the Huntington loam is used for the production of tomatoes and vegetables to supply the local canneries. A high-grade tomato is produced and the various vegetable crops prove satisfactory and give paying returns.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Huntington loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17574.....	Soil.....	0.1	1.1	0.9	10.7	21.2	50.3	14.7
17575.....	Subsoil.....	.1	.9	1.8	16.3	25.8	30.9	15.8

TOXAWAY FINE SANDY LOAM.

The Toxaway fine sandy loam, to a depth of 12 inches, is a brown fine sandy loam containing numerous mica flakes and a fair percentage of organic matter. It is underlain to a depth of 36 inches or more by a material of the same character, though slightly heavier in texture and a little lighter in color, generally, passing at about 30 inches into a rather sticky clay loam. The surface soil varies from a rather light to a heavy fine sandy loam, with the sand content chiefly of the finer grades. The color also varies to some extent according to position—the lower depressions having the darker brown color. The heavier phase of the soil occurs in these depressions. The soil is cultivated without difficulty.

The topography is comparatively level to very gently rolling or undulating, and the drainage is generally adequate, the soil being

rather loose textured and porous. Occasional small areas have rather sluggish drainage, necessitating the use of open ditches or tile drains.

The Toxaway fine sandy loam is found at varying intervals along the courses of Little and New rivers as narrow marginal strips, seldom over 100 or 200 yards wide.

The soil is alluvial in origin, having been derived chiefly from material transported by the rivers and deposited during periods of overflow. It is the most recent soil of the area. The presence of material derived from the disintegration of crystalline rocks and schists indicates that at least a part of the soil has been transported from the headwaters of these streams. This feature of the alluvial soils along these streams distinguishes them from the alluvial soils of the other streams of the area, which do not drain regions of crystalline rocks. No doubt a part of this soil is derived from the disintegrated material transported from the surrounding slopes through the action of the surface waters.

The Toxaway fine sandy loam, though limited in extent, is one of the most desirable soils in the county. Practically all of it is under cultivation, with wheat as the chief crop, and good yields are obtained. Occasional areas are used almost exclusively for the production of hay, which yields $1\frac{1}{2}$ to $2\frac{1}{2}$ tons to the acre, and as pasture. Corn yields from 40 to 75 bushels to the acre. This soil will produce good yields of melons and the various quick-maturing vegetables. Tomatoes would no doubt make excellent yields, and they could be produced in commercial quantities.

The type has a value of from \$50 to \$100 an acre, according to location.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Toxaway fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17560.....	Soil.....	0.0	0.3	1.4	37.6	18.1	30.2	11.9
17561.....	Subsoil.....	.0	.1	.4	28.5	27.6	31.9	11.6

INDIAN LOAM.

To a depth of from 8 to 10 inches the Indian loam consists of a grayish loam, often approaching a sandy loam and containing very small rock fragments derived from a quartzose sandstone of a grayish color. It is underlain by a yellow to reddish-yellow material of similar texture, grading into a redder and heavier subsoil. At about 30 inches it passes into a reddish sandy clay. The sandstone and quartz fragments are more or less numerous especially on the crests of

the rounded hills and ridges. These fragments are often sufficiently abundant to make the type a stony loam, but such areas are not large enough to warrant separation. The subsoil has something of a greasy, slick feel, due to its derivation from the underlying micaceous material.

The Indian loam occurs as a single small area in the extreme southwestern section of the county, adjacent to Little River. It has a hilly to rolling topography and drainage is excellent. The area is somewhat eroded.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Indian loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17558.....	Soil.....	0.9	6.8	6.6	32.5	7.7	38.2	7.7
17559.....	Subsoil.....	.6	3.9	5.7	19.9	10.6	18.1	41.9

HOLSTON SILT LOAM.

The Holston silt loam, to a depth of about 10 inches, is a gray to yellowish-gray silt loam. The subsoil to a depth of 36 inches or more is a yellowish to reddish-yellow clay loam, passing into a clay of the same color. The surface carries a few rounded cobbles of sandstone and the entire section is quite silty. It occurs in two small areas near Shawsville, along the course of the Roanoke River, occupying adjacent elevations. The type is not extensively developed and is of very little agricultural importance.

The material is chiefly residual, having been derived from the underlying sandstone and shaly formations. The presence of a few rounded cobbles would indicate that it was remotely influenced to some extent by river action. It is a soil more or less easily cultivated. A part of the type is utilized as pasture for sheep and cattle. The cultivated areas are used for the general farm crops with fair to good yields.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Holston silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17579.....	Soil.....	2.0	4.2	2.6	6.4	7.6	58.0	17.3
17580.....	Subsoil.....	.9	3.2	1.3	3.8	5.0	40.8	44.4

MEADOW.

The Meadow includes areas of sandy loam, stony loam, and clay occurring at irregular intervals as narrow marginal strips along the courses of some of the smaller streams. It is always low-lying and represents the wash from surrounding elevations during seasons of excessive rainfall. Much of it is subject to overflow. The kind of soil in the immediate vicinity largely determines the character of the materials laid down along the stream courses in the Meadow areas, though there is a mixture of material brought down by the streams from their sources.

Some of the Meadow is under cultivation and is very productive, though a great part of it is of little agricultural value. Where not too stony it is one of the best soils of the area for corn and hay, corn yielding from 40 to 75 bushels and hay from $1\frac{1}{2}$ to $2\frac{1}{2}$ tons to the acre. The area of Meadow is limited. The valleys are narrow and afford little opportunity for the accumulation of transported soil. The Meadow has a value ranging from \$5 to \$75 an acre.

PARIS LOAM.

The Paris loam consists of 10 inches of a dark brownish to very dark gray loam, with occasional spots almost black. There is generally an accumulation of organic matter in the soil, which no doubt accounts for much of the dark color, and numerous huge boulders outcrop at irregular intervals. The subsoil is brownish to reddish-brown clay loam passing at about 20 inches into a heavy reddish to reddish-brown clay. The soil is more or less easily cultivated and very productive.

It is found on the crests of Paris and Fort Lewis mountains, where a rather level table-land affords limited areas for cultivation. The depressions and coves which extend down the slopes present the darkest phase of the soil. The drainage is good.

While this soil is very productive it has a low value, owing to its inaccessible position. Corn, the chief crop, will yield from 40 to 65 bushels to the acre. Other crops adapted to the region do well.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Paris loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17570.....	Soil.....	1.2	8.1	4.5	21.5	14.0	34.5	16.0
17571.....	Subsoil.....	2.5	7.6	4.6	21.2	11.4	22.3	30.5

CUMBERLAND CLAY LOAM.

The soil of the Cumberland clay loam, to a depth of 8 to 12 inches, is a brownish to grayish-brown clay loam, carrying some of the finer textured sand and a low percentage of rounded waterworn cobbles. The subsoil is a reddish-brown to reddish heavy clay loam to clay which extends to a depth of 36 inches or more. The type is cultivated with some difficulty on account of the heavy nature of the soil, but when properly handled it responds readily in good yields.

It is found in a single area just to the east of Shawsville between the high uplands and the first river bottoms. In this position it represents wash from the limestone hills and, no doubt, some material laid down at an earlier period by the streams. The former unquestionably affects the color of the soil, which is more pronounced in areas immediately adjoining the limestone formation. The topography is gently rolling and the drainage is good.

Most of the Cumberland clay loam is utilized as pasture, though small parts of it are cultivated in the general farm crops, chiefly corn. The yields are invariably good.

SUMMARY.

Montgomery County comprises an area of 251,776 acres, or about 393 square miles, and is situated in southwest Virginia in the second tier of counties from the West Virginia line, within what is known as the "Valley of Southwest Virginia." The northern and eastern parts of the county are mountainous and rough. The southern part is a rolling valley and meets the dissected upland known as the Floyd-Carroll-Grayson plateau near the southern boundary. A drainage divide crosses the center of the county from north to south, forming two drainage systems, one toward the west, the other toward the east. The western system comprises Little and New rivers and their tributaries, whose waters ultimately reach the Gulf of Mexico. The eastern system includes the North and South forks of the Roanoke River flowing toward the Atlantic.

Christiansburg, a town of about 1,000 inhabitants, near the center of the county, is the county seat. The Norfolk and Western Railroad, dividing the county into nearly equal parts, furnishes the transportation facilities. Montgomery County has a fairly well distributed population of 16,000, of which number 3,000 are colored. Thirty or forty miles of the roads are macadamized, and all the turnpike roads are fairly good.

Brickkilns, limekilns, and canning factories are successfully conducted in various sections of the county, and lumbering and coal mining are carried on to some extent.

The winters are mild and the summer temperature is about 72° F. The growing season is six months long, and rainfall is well distributed throughout.

Tobacco, once the important crop, is not grown extensively at present. The chief crops are corn, wheat, oats, clover, and grasses. Tomatoes and beans are grown to supply the local canneries. Sheep and cattle raising is a very important industry, and can be considerably developed.

The rolling valley lands and bottom lands along the larger streams mark the more progressive farming sections. Although manure is used to some extent, the supply is inadequate and commercial fertilizers are used to a great extent, especially for grain, tobacco, and vegetables.

The bulk of the labor is negro, and is efficient. The day wage is \$1 to \$1.50. The farms are either operated by the owners or by share tenants, the share system predominating.

The agricultural methods include some sort of rotation, the most noticeable one being the seeding of grass with wheat, and allowing the grass to grow for a year or two for hay or for grazing.

Increased yields could be obtained on the soils of the county by deeper plowing and by following a crop rotation, including a leguminous crop to be plowed under. The addition of organic matter in this way, together with applications of barnyard manure, would greatly increase the productiveness of the soils.

The soils of Montgomery County are chiefly derived from limestones, sandstones, shales, and mica and talcose schists, giving rise to the Hagerstown, Dekalb, and other series, and several miscellaneous types.

The Hagerstown stony loam includes all areas of limestone material having a high stone content. On the higher elevations it is rough and broken and is used for grazing cattle. The more level parts are either cultivated or used as pasture. Where cultivation is feasible, good yields of corn and wheat are obtained. The value of the Hagerstown stony loam varies from \$10 to \$50 an acre.

The Hagerstown loam is easily cultivated and improved and is considered a good general farming soil. Its topography is gently rolling, and its drainage is excellent. Corn, wheat, and grass are the principal crops, corn yielding 30 to 60 bushels, wheat from 15 to 25 bushels, and hay from 1 to 2½ tons an acre. The soil should be used more for apple growing. Tomatoes and beans do well and are grown for the local canneries. Many of the hills are now used for grazing sheep and cattle. The type has a value ranging from \$30 to \$100 an acre.

The Hagerstown silt loam is one of the strongest and most desirable soils of the county for general farming, fruit growing, and grazing. Corn produces from 35 to 60 bushels, wheat 15 to 30 bushels, and hay 1 to 3 tons to the acre. Tomatoes also do well on this soil. Its value varies from \$75 to \$100 an acre.

The Hagerstown clay loam, like the other Hagerstown soils, is derived from limestone. It is a good general farming soil and has

excellent drainage. Careful tillage to prevent washing, together with the application of barnyard manure and the planting of leguminous crops to be plowed under, would prove beneficial.

The Decatur clay loam is a strong soil, derived from the limestone. It is easily handled and gives a good tilth. Corn yields from 40 to 60 bushels, wheat 15 to 25 bushels, and hay 1 to 2½ tons to the acre. The average value of the type is \$60.

The Dekalb stony loam is derived from sandstone and conglomerate. Only the more level areas are cultivated; the steeper parts are devoted to sheep and cattle grazing. Some chestnut and chestnut oak of moderate growth is found on the type. Where cultivated, fair yields of corn, wheat, buckwheat, and vegetables are obtained. The soil could be profitably devoted to the production of apples.

The Dekalb fine sandy loam occupies the gently rolling slopes of the valleys. It is covered for the most part with chestnut oak and pine, and little of it is under cultivation. Where cultivated, corn yields 12 to 20 bushels and wheat 5 to 12 bushels to the acre. The southern slopes are better adapted to fruit and vegetables than to general farm crops.

The Dekalb silt loam has a rolling to hilly topography. The rougher areas are used for pasture, but, where cultivated, corn yields 20 to 35 bushels, wheat 12 to 20 bushels, and hay 1 to 2 tons to the acre.

The Pilot gravelly loam is derived from crystalline rock of Archean age. The uncleared parts support a fair growth of hardwood and pine. On account of the large quantity of gravel and stone, cultivation is difficult, but, where cultivated, fair yields are obtained. It has a value of \$10 to \$35 an acre.

The Pilot loam has a hilly to gently rolling topography. Corn yields 30 to 50 bushels and wheat 10 to 20 bushels to the acre. Oats and grasses are grown for forage. Its value ranges from \$10 to \$50 an acre.

The Upshur silt loam is derived from the weathering of the red sandstones and shales of Paleozoic age. It occupies the well-rounded hills and ridges. The native timber is scrubby hardwood and some pine. Where cultivated, fair yields of wheat, corn, and hay are obtained. The type is of small extent and of little agricultural importance.

The Cumberland gravelly loam is of limited extent. The better areas are devoted to corn, wheat, oats, and grasses, and the returns are good.

The Cumberland loam, like the Cumberland gravelly loam, is made up of material laid down by rivers during a very remote period. Its topography is gently rolling to hilly, and it has excellent drainage. Corn, wheat, and vegetables are grown on this type, as well as grass for hay and pasture. It is valued at \$10 to \$100 an acre.

The Radford loam represents a mingling of alluvial, colluvial, and residual material, and occurs as a second-bottom soil. Corn yields from 40 to 75 bushels an acre. Some of the type is used for growing hay and as pasture. Its value ranges from \$25 to \$100 an acre.

The Huntington silt loam is a little higher in position than the first bottom, where the Huntington loam is found. It is very productive, corn yielding from 40 to 60 bushels, wheat 12 to 20 bushels, and hay 1 to 2½ tons to the acre. It has a value of \$60 to \$75 an acre. The drainage of the type could be improved by open ditches and tile drains.

The Huntington loam is of very limited extent. Much of the type is used for growing tomatoes, and the yields are good. Corn is the chief crop and yields from 40 to 75 bushels per acre.

The Toxaway fine sandy loam is alluvial in origin. Its topography is level to gently rolling, and drainage is good. Although of very limited extent, it is a desirable soil, and is practically all under cultivation. Corn yields 40 to 75 bushels and hay 1½ to 2½ tons to the acre. It is valued at \$50 to \$100 an acre.

The Indian loam, Holston silt loam, and Meadow are of relatively small extent. The latter, where cultivation is practicable, gives good yields. Corn produces 40 to 75 bushels and hay 1½ to 2½ tons to the acre.

The Paris loam, although very productive, has a low value owing to its inaccessible position. Corn, the chief crop, yields from 40 to 65 bushels per acre.

The Cumberland clay loam is found in a single area just east of Shawsville. Its topography is gently rolling and its drainage is good. It is chiefly used for pasture, although where cultivated the general farm crops give good returns.

SOIL SURVEY OF HENDERSON COUNTY, NORTH CAROLINA.

By **W. EDWARD HEARN**, Assisted by **G. M. MacNIDER**, of the North Carolina Department of Agriculture.

DESCRIPTION OF THE AREA.

Henderson County lies in the southwestern part of the State of North Carolina, and is included in the Saluda and Pisgah quad-range sheets of the United States Geological Survey. The county is bounded on the north by Buncombe County; on the northeast and east by McDowell, Rutherford, and Polk counties; on the south by the South Carolina State line, and on the west by Transylvania



FIG. 6.—Sketch map showing location of the Henderson County area, North Carolina.

County. It comprises an area of 234,240 acres, or about 366 square miles. The outline of the county is very irregular, following in many places the tops of ridges or of mountains; especially is this true of the northern and eastern boundaries.

It is a typical mountain county, consisting of mountain ranges, isolated peaks, a rolling plateau, and level areas of valley land. The western end of the county touches the Pisgah ridge, while the eastern and southern sides lie along the Blue Ridge range and Saluda

Mountains. The elevation of the county varies from 1,400 feet near Bat Cave to 5,000 feet on Little Pisgah Mountain, while at Hendersonville it is about 2,150 feet. The general slope of all the western, central, and northern parts of the county is toward the French Broad basin, of the northeast corner to the east, and of the extreme east and southeast parts toward Green River. The most rugged topography is in the western and northeastern parts and along Green and Hungry rivers. Many of the mountains rise to an elevation of 4,000 feet or more. The more important peaks are Black Mountain, Johnson, Shell, and Stony knobs in the western end; Bear Wallow Mountain in the northeastern part; Sugar Loaf Mountain, the highest point in the Blue Ridge range in Henderson County, in the east, and Pinnacle and Stony mountains in the south. These mountains are in many cases steep, and the small streams have carved out deep, narrow gorges or valleys in their heavy fall to lower levels. There are many badly dissected areas, especially along Green and Hungry rivers, in the northeast corner, and in the western end of the county. Several escarpments occur near the drainage lines in the vicinity of Bat Cave and Pinnacle Mountain, where almost perpendicular bare rock walls are prominent.

One of the most noticeable features of the topography of Henderson County is the broad, rolling intermountain plateau, covering about 60 or 75 square miles, in the vicinity of Hendersonville, Flat Rock, and northeast to Fruitland. This plateau has an elevation of from 2,100 to 2,300 feet and resembles in many respects the Piedmont section of the State. It constitutes the greater part of the rolling upland in the county. In the west-central part of the county lies the French Broad Valley, varying in width from one-quarter mile to 1½ miles. This, together with the valleys along Mills River and Cane and Mud creeks, constitutes practically all the level bottom land in the area.

The county has excellent natural surface drainage, effected through the many rivers and creeks within its borders. The drainage is divided between the waters flowing toward the Gulf of Mexico and those flowing toward the Atlantic Ocean. The French Broad River, with its tributaries—Mills River and Boyleston, Mud, Clear, Cane, and Hooper creeks, which drain the western and central parts of the county—flows toward the Gulf. The Broad River, with its tributaries—Hickorynut and Readypatch creeks—drains the northeast corner; while the Green, Hungry, and Little Hungry rivers carry the drainage waters of the extreme eastern and southern parts; these streams flow toward the Atlantic Ocean. All the streams except the French Broad River and Cane and Mud creeks are very swift flowing, falling in heavy grades down the mountain sides. In many places

there are beautiful waterfalls where much power could be easily and cheaply developed. All the gristmills in the county and several saw-mills are operated by water power. Most of the farm houses could be supplied by gravity with spring water from the mountain sides.

Prior to 1861 Henderson County was considerably larger than it is at the present time. Practically all the population are descendants of the first settlers, who were American-born whites and who moved into the county from other parts of the State. Only a very small percentage of the population is colored.

Around Hendersonville, Flat Rock, northeast of Fruitland, and throughout the French Broad Valley and the valleys of other streams the county is fairly well settled. In the remoter parts and in the mountainous regions it is very sparsely settled, and there are few inhabitants in the extreme western part of the county. The soil, climate, and other natural advantages of Henderson County should attract settlers, and the county could support a population many times the present number, which is about 15,000.

Hendersonville, the county seat, with a population of 2,500, is the largest and most important town. Flat Rock, Horse Shoe, and Fletcher are small places, and there are many sidings and stations along the railroads in the county from which shipments of farm and forest products are made. Hendersonville and many other places in the county, especially in the Flat Rock vicinity, where there are many beautiful summer homes, are noted summer resorts.

The Asheville and Spartanburg branch of the Southern Railway crosses the county in a general north-and-south direction. The Toxaway branch of the same system leads out from Hendersonville through the western part of the county. These roads afford good transportation facilities. The rural free delivery of mail is established throughout the greater part of the county. Neat school-houses and churches have been built in the better developed sections.

There is a good market at Hendersonville for some cattle, hay, garden vegetables, potatoes, fruits, chickens, and eggs, all of which bring high prices. A considerable quantity of such products can be disposed of at Flat Rock and Saluda during the summer months. Potatoes and cabbage are shipped during July and August to Charleston and Columbia, S. C.; Augusta, Ga.; Birmingham, Ala.; and a few points in Florida. Some apples are shipped to eastern and southern towns. A few cattle find their way to market at Asheville, Richmond, Va., and points in South Carolina.

AGRICULTURE.

Agricultural development in Henderson County is most marked in the vicinity of Hendersonville, along the valleys of the French Broad

and Mills rivers, and on some of the larger streams. The county has been settled for a long time and the advancement has been slow but steady. Considerable stimulus was given to agriculture by the building of the Asheville and Spartanburg branch of the Southern Railway in 1878, and a further impetus was added in 1896, when the Toxaway branch of the same road was built through the western part of the county.

In several parts of the county are seen neat, painted frame houses, with fairly good barns and other improvements. The best farms are supplied with modern labor-saving machinery and fairly well stocked with work animals and cattle. In some of the more remote and mountainous sections the farm buildings are small and the general appearance denotes less thrift and advancement.

The first crops to be grown were corn, wheat, rye, grass, potatoes, and cabbage. At one time a considerable quantity of tobacco was produced, but the decline in prices discouraged the farmers, and this crop is no longer grown on a commercial scale. On the other hand, the production of potatoes and cabbage on a commercial scale has been gradually increasing for the last twenty years. Cattle have been raised since the settlement of the area. Apples have been the main fruit crop and many of the old trees are still bearing.

At present corn is the principal crop grown in Henderson County, being produced on every farm and on every variety of soil. The important secondary products are wheat, grass (timothy and redtop), Irish potatoes, cabbage, and rye. Irish potatoes and cabbage are the staple money crops in many parts of the county. Some rye is grown with a fair degree of success. Apple orchards are seen around every well-established homestead, and on a few of the mountain sides some of the farmers are growing apples on a commercial scale. A few peaches, pears, and cherries are grown. Some cattle are raised for market, and hogs are kept on the best farms. Only a few sheep are raised, although the climate and natural grazing advantages favor this industry. There is one ginseng farm in the county, and the culture of this herb is said to be very profitable. A small quantity of cowpeas and clover, sweet potatoes, tomatoes, tobacco, and sorghum, from which sirup is made for home use, are grown. Garden vegetables are grown both for home use and for sale in Hendersonville and other near-by markets. In addition to the farm products there is a fairly large revenue derived from the sale of cord wood and of tan bark, taken mainly from chestnut oak, with a little from hemlock. Many cross-ties are sold, but the cutting of the trees for this purpose means the destruction of timber which in a few years would be much more valuable. A little merchantable timber is being sawed in the county.

A few farmers have recognized the importance of the adaptation of soils to crops. The Toxaway loam has long been considered the best soil in the county for corn and grasses, while the more uniform areas of the Toxaway fine sandy loam are almost equally favorable for the production of these crops. The Porters clay is the best wheat and clover land in the county. Potatoes, truck, and garden vegetables do well on the Porters sandy loam. The Porters loam and Porters sandy loam are admirably suited to the production of a number of varieties of apples, among which are the Winesap, Stayman Winesap, York Imperial, Albemarle Pippin, Ben Davis, and some earlier kinds. The best location for orchards is usually on northern, northeastern, and northwestern slopes, at an elevation of from 2,400 to 3,500 feet. Such an altitude is commonly above the frost or fog line and the air drainage is also likely to be good.

On some of the best farms a rotation of corn, wheat, and rye, and sometimes of corn, wheat, rye, and grass is practiced, but the usual rotation is corn one year and grass the next. Some sow oats and grass together in the spring, producing a crop of oats and securing a stand of grass. In many parts of the county little attention is paid to rotation and the same field is devoted to the same crop year after year.

Several of the best farmers are practicing improved methods, especially in the growing of corn, where level, shallow cultivation has supplanted the ridging or bedding of rows. Many of the farmers are buying the latest improved machinery, and the results obtained amply justify its use where the character of the surface is favorable, as in the rolling areas and level bottom lands. In the more mountainous localities the surface is generally too rough to allow the use of much machinery.

Throughout the county farm labor is scarce. Day laborers receive \$1 per day and those working by the month from \$15 to \$25 and board. In the more remote and mountainous sections many women assist in the field work.

Nearly all the farms in Henderson County are operated by the owners. Those tenanted are generally farmed on a share basis. The size of the farms varies greatly. In the vicinity of Hendersonville and in many other localities there are a number of farms which range in size from 15 to 60 acres. Many of the best farms contain about 75 acres under cultivation and more or less woodland, in all from 200 to 500 acres. One lumber company owns about 9,000 acres in a single tract, while 30,000 acres, or practically all of the western end of the county, is included in the Vanderbilt estate.

Within the last few years both the farming and timber lands have increased greatly in value. The rough mountain lands are now held at \$5 or \$6 an acre, the cultivated mountain land at \$10 to \$25, and

land in the valley and in the rolling plateau around Hendersonville at prices ranging from \$20 to \$75 an acre, depending on location and improvements.

Some fairly good roads are found in Henderson County, but there is need of more, and nothing would do more to enhance the value of farming lands than an extension and improvement of the road system. The rough mountainous areas should remain forested, or when denuded of their timber should be used for pasture. Apple orcharding on the mountain sides would be a profitable industry and one which should be developed. More cattle could be easily and cheaply raised on the land now lying idle, and the dairy and poultry industries ought to be extended. Considerable quantities of corn, hay, and meat are annually bought by some of the farmers at high prices. At least enough of these products for home use should be produced on the farm.

In the matter of general improvement of the soils more care should be taken in saving the barnyard manure. Many more acres of land could be kept in a state of high productiveness if the manure were protected from the leaching effect of rains. The loss through washing away of the valuable ingredients of the manure in the aggregate amounts to thousands of dollars each year. Deeper plowing and a better preparation of the soil before planting should be practiced. Improved seed, especially of corn, wheat, and potatoes, ought to be used. Clover and grass seed should be tested before being sown. It is believed that lime, which can be secured at Fletcher and along Boylston Creek, can be used with profit on all the soils in the county.

CLIMATE.

The following tables, compiled from records of the Weather Bureau station at Hendersonville, show the mean monthly and annual precipitation and temperature and the occurrence of early and late killing frosts. The winters are comparatively mild, while the summers are cool and pleasant. The precipitation is fairly well distributed throughout the year, although a slightly greater amount falls during the summer months.

The average date of the last killing frost in the spring is April 23, and of the first in the fall October 21. There is thus for the tenderest plants a growing season of about 180 days.

The air is dry, bracing, and invigorating, and this fact, coupled with the topography and excellent water from the numerous springs on the mountains, makes this section of North Carolina an ideal summer resort, as attested by the thousands who go there each season.

Normal monthly and annual temperature and precipitation.

Month.	Hendersonville.		Month.	Hendersonville.	
	Temperature.	Precipitation.		Temperature.	Precipitation.
	° F.	Inches.		° F.	Inches.
January.....	37.1	4.57	August.....	73.3	7.78
February.....	38.3	7.38	September.....	65.7	4.55
March.....	46.2	7.64	October.....	56.2	4.24
April.....	53.4	5.04	November.....	46.5	2.98
May.....	63.9	4.18	December.....	38.8	5.24
June.....	70.3	6.39			
July.....	72.9	5.91	Year.....	55.2	65.90

Dates of first and last killing frosts.

Year.	Hendersonville.		Year.	Hendersonville.	
	Last in spring.	First in fall.		Last in spring.	First in fall.
1900.....	May 11	Nov. 7	1904.....	Apr. 22	Oct. 15
1901.....	Mar. 29	Nov. 3	1905.....	Apr. 19	Oct. 13
1902.....	Apr. 14	Oct. 15	1906.....	May 10	Oct. 11
1903.....	Apr. 24	Oct. 19	Average.....	Apr. 23	Oct. 21

SOILS.

The rocks forming the soils in Henderson County comprise three great classes—igneous, sedimentary, and metamorphic. The sedimentary rocks are found in a narrow band, varying in width from 1 to 2 miles, stretching across the county in a general northeast-southwest direction. This formation, which has been classified^a as Brevard schist, is of Cambrian age, the rocks consisting of mica schists and dark-gray or black shales. At several places in this formation there are beds of limestone which have been used extensively as a source of agricultural lime. At one place in the formation (near Fletcher) the rock is of such purity that it is burned on a large scale for building lime.

Northwest and west of the belt of Cambrian rocks is a large body of metamorphic rocks classified as Carolina gneiss. This formation consists mainly of light to dark gray mica gneiss and hornblende gneiss. These rocks offer greater resistance to weathering than the rocks of any other formation and hence the highest mountains are found in this portion of the county. South and east of the Cambrian formation are found the rocks of igneous origin. Adjoining the Cambrian rocks is an area of Henderson granite; this is a gneissoid

^a The classification of the rocks in this county is taken from the Pisgah Folio of the U. S. Geological Survey, by Arthur Keith.

granite composed of orthoclase and plagioclase feldspars, quartz, muscovite, and biotite. Throughout this rock the crystals of orthoclase feldspar are of a porphyritic nature, frequently an inch or more in length. To the south and east of the Henderson granite is a large area of Whiteside granite. This is a finer grained rock than the Henderson granite and is composed of orthoclase and plagioclase feldspars, quartz, muscovite, and biotite. Scattered through this granite area are small outcrops of the Carolina gneiss and the Roan gneiss composed of dark-colored hornblende gneiss and schists.

The soils of Henderson County may be divided into two general classes—the soils derived in situ from the rocks described above, or residual soils, and the soils which owe their origin to stream action, or alluvial soils. The residual soils occupy the uplands, and consist principally of loams, sandy loams, and clays; they are typical of the soils of the mountain region and have been classified in the Porters series. The alluvial soils are found in the valleys and are very fine-textured loams and fine sandy loams, belonging to the Toxaway series.

The soils derived from the rocks of the Cambrian formation are dark-red, fine-textured clays. Where the forest cover has been left undisturbed, and a considerable proportion of organic matter has consequently accumulated, the Porters loam is found. The typical soil of this belt, especially along the foothills, is the Porters clay.

The rocks of the Carolina gneiss formation disintegrate slowly, forming a fine, even-textured loam known as Porters loam. In this area the forest cover is usually heavy, consequently the soils contain a considerable quantity of organic matter. In the coves and along some of the streams, where the vegetation is quite heavy, the accumulation of vegetable matter is large, giving rise to the Porters black loam. In some of the thinly forested areas, where the rocks are not thoroughly decomposed, spots of Porters sandy loam occur.

Over the area south and east of the Cambrian belt, which is covered by the granites, the Porters sandy loam is the typical soil. Both the Henderson and Whiteside granites disintegrate readily, forming a rather coarse-textured sandy loam. In the rolling areas in the central part of the county these rocks are well decomposed, forming a mellow sandy loam with a red clay subsoil. In the more mountainous regions, where the decomposition has not been as thorough, the sandy loam is coarser in texture. On many of the mountains and ridges in this area the rocks come very near the surface, frequently outcropping. Decomposition has progressed very slowly in these areas and the resultant soil, which is frequently not over 10 inches deep, is a coarse, gravelly, light-gray or yellow sandy loam. In some localities where these rocks are very thoroughly decomposed or where the Roan gneiss occurs, small areas of the Porters loam are found. In a few localities

along the French Broad River, where the Henderson granite is very thoroughly decomposed, small areas of Porters clay occur.

The alluvial soils are found in the valleys of the rivers and larger creeks. When the materials washed down from the mountains were held in suspension by comparatively rapid moving water very little silt and clay were deposited, and the materials laid down consist largely of fine-grained sand and mica scales. These materials, modified by the addition of vegetable matter, give rise to the Toxaway fine sandy loam.

At times of overflow, when the valleys were covered by large bodies of slow-moving water, a large amount of silt and clay was deposited. These frequent overflows kept the valleys for a long time in a semi-swampy condition, during which period large quantities of vegetable matter accumulated in the soil. This has given rise to a dark-gray or black, heavy, fine-textured loam, classified as Toxaway loam.

Eight distinct types of soil, exclusive of Rock outcrop, have been recognized and mapped in Henderson County. The name and extent of each type are given in the following table:

Areas of different soils.

Soil.	Acres.	Percent.	Soil.	Acres.	Percent.
Porters sandy loam.....	115,264	49.2	Rock outcrop.....	2,112	0.9
Porters loam.....	70,656	30.2	Meadow.....	1,024	.4
Porters sand.....	19,328	8.3	Porters black loam.....	320	.1
Toxaway fine sandy loam.....	14,336	6.1	Total.....	234,240	.....
Porters clay.....	7,296	3.1			
Toxaway loam.....	3,904	1.7			

PORTERS SANDY LOAM.

The surface soil of the Porters sandy loam consists of a yellowish-gray to gray, medium to coarse sandy loam, varying in depth from 6 to 15 inches. In a few localities a gray fine sandy loam is encountered, while in some other places, where erosion has been quite active or where the rock is more thoroughly decomposed, a reddish or brown heavy sandy loam is seen. The Porters sandy loam and the Porters loam grade almost imperceptibly into each other throughout the eastern part of the county. In some of the heavily forested areas the soil is more loamy and darker in color, owing to the accumulation of organic matter. Occasionally a few mica scales occur in the soil. Some quartz gravel and rock fragments are scattered over the surface in many places, and sometimes pockets of quartz gravel are seen in the soil to a depth of several inches. The Porters sandy loam is a mellow, loose, and friable soil, is easily tilled, and if properly managed never bakes.

The subsoil varies considerably in texture and color. A thin upper layer is usually a reddish or yellowish brown, heavy, sticky sandy loam, which grades into a red or yellow clay loam or clay. In the vicinity of Hendersonville and eastward to Blue Ridge the subsoil is generally a red clay loam or clay, although yellowish areas are present here and there. It occurs with less uniformity in the more mountainous section and frequently the disintegrated rock comes within 3 feet of the surface, such areas and spots resembling the Porters sand.

The Porters sandy loam has the largest development of any type in the county. It covers practically all of the central and eastern parts, occurring in large continuous areas. It is also largely developed in the northeast and southwest parts, and is particularly important in the vicinity of Hendersonville, Flat Rock, Saluda, Horse Shoe, Blue Ridge, and Edneyville.

This soil type varies greatly in surface features, occupying broad, rolling and hilly to mountainous areas. The more level and rolling areas occur around Hendersonville, Flat Rock, and northeast toward Fruitland, covering practically all of this intermountain plateau. The rougher, more broken bodies are seen in the northeast corner of the county, to the southwest of Hendersonville, and along Green and Hungry rivers. In these localities the mountains attain an elevation of 3,000 to 4,000 feet in many places and the sides are steep, and in limited areas are so rugged that general farming operations can not be profitably carried on. The soil is well drained, both on account of its open texture and rolling to mountainous topography. On some of the mountain slopes where cultivation has ceased gullies have been formed. Considerable washing can be prevented by deeper plowing, thus enabling the soil to absorb more of the rainfall.

The Porters sandy loam is a residual soil derived from the weathering of Henderson and Whiteside granites. These rocks have disintegrated and decomposed to a depth of several feet in many places, thus giving a sandy surface and a red or yellow clay loam to clay subsoil. In a few localities, especially on the steeper slopes, the partly disintegrated rock is found near the surface.

The forest growth on the Porters sandy loam consists mainly of white, post, red, and chestnut oak, with a scattering growth of pines of different species. Some chinquapin and chestnut occur on the ridges, while in the heavily forested areas and coves an abundance of laurel and rhododendron is seen.

This is the most important soil type in the county from an agricultural standpoint and also from its extensive development. It grows every crop common to the county. It is well suited to the production of Irish potatoes, garden vegetables, rye, corn, wheat, and cabbage. On the higher elevations orchard fruits do well, and berries and grapes can be grown almost anywhere. The rough mountain

areas and steep slopes should remain in permanent forest, or if cleared should be devoted to pasture.

Corn yields from 10 to 20 bushels per acre on an average, and as high as 50 bushels have been produced by some of the best farmers. Rye yields from 8 to 20 bushels, wheat from 7 to 15 bushels, and Irish potatoes from 60 to 200 bushels. Oats, clover, and timothy give fair yields. Cabbage yields from 4 to 6 tons per acre when properly manured. Sweet potatoes, sorghum, tobacco, apples, berries, tomatoes, and garden vegetables are all grown with good results. A small field of ginseng was found, and this crop is said to do well when partly shaded.

For some of the farm crops, and especially the truck crops, commercial fertilizer is used. Some farmers buy a complete fertilizer, with the formula 2:8:2, while others use cotton-seed meal, acid phosphate, and kainit, and do their own mixing. A little lime is occasionally used. This type of soil can be greatly improved by growing leguminous crops and turning them under until the soil is filled with humus. More barnyard manure is needed. When a heavy green-manuring crop is turned under, the application of 30 or 40 bushels of lime per acre gives noticeably increased yields. Deeper plowing, more thorough cultivation, and a systematic rotation of crops are necessary for the most profitable management of this soil.

The value of the Porters sandy loam varies according to location and topography. The roughest areas sell at \$5 and upward an acre; the farming land east of Hendersonville brings about \$15 to \$25 an acre, while near Hendersonville and in the Flat Rock vicinity it is held at much higher prices.

The average results of mechanical analyses of samples of the Porters sandy loam are given in the following table:

Mechanical analyses of Porters sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17829, 17831.....	Soil.....	2.1	12.2	9.1	27.4	11.9	24.9	12.4
17830, 17832.....	Subsoil.....	1.7	10.1	6.8	21.2	11.0	17.9	29.9

PORTERS LOAM.

The soil of the Porters loam consists of a dark-brown, reddish-brown, or yellowish-brown loam 6 to 14 inches deep. The surface is usually darker than the underlying soil on account of the accumulated vegetable matter. Throughout the mountainous areas, where the forest growth is heavy, there occur areas of very dark brown or black loam. In some of the deeper coves at the heads of streams the loam grades into Porters black loam, but these areas are so small

that they have not been shown on the map. Where the soil is thinly forested, on the foothills and ridges, small areas of a grayish loam occur, and where the granitic rocks come near the surface there is a marked increase in the sand constituents. In a few areas the soil is very stony, but as a rule it is mellow and easily tilled.

The subsoil varies from a reddish-brown or red to a yellowish-brown clay or clay loam. In some localities where it is derived from a mica schist the subsoil is deeper red in color, and both soil and subsoil contain a considerable amount of mica. Areas occur, particularly in the western part of the county, where the subsoil is a brown mellow loam, but on the foothills it is usually a stiff red clay.

The Porters loam is one of the most important types forming a large unbroken area in the mountainous western part of the county. Practically all of the Vanderbilt estate is covered by this type. Other large bodies are found in the northern, southern, and eastern parts, and smaller isolated areas occur throughout the county.

The topography varies from rolling to mountainous, and the elevation ranges from 2,000 to 5,000 feet. The rolling areas are found in the vicinity of Fletcher, Otanola, and west of Horse Shoe. In the rolling areas and where the type occurs on the foothills of the mountains it can be cultivated easily, but in the mountainous areas it is too steep and rugged for cultivation. On account of its topographic position the surface drainage is excellent. Where the forest cover is removed and the soil improperly cultivated erosion is very active and the fields soon become badly washed and gullied. The heavily forested areas are well watered by many springs.

The Porters loam is a residual soil derived from a variety of rocks, from the fine-grained schists of the Brevard formation to the coarse, gneissoid Henderson granite. The largest and most typical areas are found in the western part of the county, where the Carolina gneiss predominates. This formation consists of mica gneiss and mica schist, and the Porters loam is the characteristic soil derived from these rocks. They are usually deeply weathered, though they sometimes lie near the surface, and the soil is red and reddish brown, the addition of considerable vegetable matter having deepened the color of the surface soil. East of this area is found the belt of Cambrian rocks known as Brevard schist. This formation consists of mica schists and dark-colored fine-grained shales, which in the more heavily forested areas gives rise to the Porters loam. Here the soil is usually more red in color and contains large amounts of micaceous material. The central and eastern parts of the county are covered by the Henderson and White-side granites, which do not give rise to the loam unless they are deeply weathered and heavily forested, so that the loam areas in this part of the county are small. In the eastern and southeastern parts of the county there are a few areas of the Carolina and Roan gneiss which

give rise to the loam. The hornblende rocks of the Roan gneiss form a dark-brown or dark reddish-brown loam.

The forest growth on this type consists largely of hardwood, principally white, chestnut, red, post, scarlet, black, and shingle oaks, hickory, chestnut, and poplar. Of the conifers, white pines are found in some quantity in a few sections, a few shortleaf and scrub or Jersey pines, and in the mountainous areas along streams a few hemlocks. There is generally an undergrowth of *Kalmia* or mountain laurel and *Azalea*, and in the coves and along the streams rhododendron is abundant and reaches a large size. Medicinal herbs are gathered to a small extent in the mountainous areas, but this industry is not as important as in the more mountainous counties.

As the greater portion of the Porters loam occurs in the mountainous section of the county, where it is too rugged for profitable cultivation, it should be kept permanently in forest. The gentle slopes and coves are well adapted to apple culture, and this industry can be very profitably developed on a commercial scale. The northern, northwestern, and northeastern exposures have been found to be the best for orchards, and if these are located on the higher slopes the fruit is unlikely to suffer from frost. Where the gentle slopes of this soil are cleared it makes excellent pasture and the grazing of sheep and cattle can be made a very important source of revenue. The rolling areas and the foothills of the mountains are practically the only portions of this type cultivated to any extent. It is well adapted to corn, wheat, rye, potatoes, and cabbage. Corn yields from 12 to 30 bushels and wheat 8 to 20 bushels per acre. Large yields of cabbage and potatoes are obtained. Considerable rye is grown and a small acreage of oats and tobacco. No tobacco, however, is put on the market. Apples are grown to some extent, but very few are shipped out of the county. A few peaches and plums are produced. In the vicinity of the lime kilns lime is used on this soil, with very beneficial results. Practically no commercial fertilizer is used.

The cultivable areas of the Porters loam are valued at \$10 to \$50 an acre, depending on the distance from the railroad. The rugged, mountainous areas, which can not be cultivated, are valued at \$5 or \$6 an acre.

The average results of mechanical analyses of samples of the Porters loam are shown in the following table:

Mechanical analyses of Porters loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17323, 17325.....	Soil.....	1.1	8.2	6.5	20.9	5.8	37.4	19.3
17324, 17326.....	Subsoil.....	1.1	8.3	6.2	19.0	8.4	24.3	32.1

PORTERS CLAY.

The soil of the Porters clay is a red or brownish loam, having an average depth of 5 or 6 inches. In a few places the surface is a yellowish or gray loam or heavy sandy loam for a few inches, while on some of the knolls and eroded areas a rather stiff red clay is encountered at the surface. Occasionally a few shale and schist fragments, rounded quartz gravel, and a little mica are scattered in the soil. Generally the soil is fairly easy to till, as there is present a sufficient quantity of sand and silt to make it friable.

The subsoil of the typical areas is a stiff red clay to a depth of several feet. Spots of yellowish and reddish-yellow clay occur in a few localities. On some of the ridges and sides of the knolls the partially decomposed rock comes within 3 feet of the surface, and in such places there are small fragments of the rock in the subsoil.

The Porters clay is confined exclusively to the west-central part of the county. The largest bodies lie along Boylston Creek and the French Broad River. Many smaller isolated bodies occur around Etowah, Horse Shoe, and Gypsy.

This type occupies the knolls, ridges, and foothills of the mountains in the French Broad basin, having generally a rolling to hilly surface and an elevation of from 2,100 to 2,300 feet. Most of the areas can be cultivated, and all may be used for pasture. The natural surface drainage is good, in fact, often too rapid, and many gullied areas were seen where erosion had been severe. In such places deeper plowing and seeding to grass should be practiced to prevent further waste of the land.

The Porters clay is a residual soil derived from the weathering of the Brevard formation, composed mainly of a dark-gray to black schist, with some banded mica shale. The formation contains oxide of iron and minute scales of mica. Some limestone rock also occurs in this formation and possibly has influenced the soil in some places. On the east side of the French Broad River the areas of Porters clay are derived from granite rocks, where these have thoroughly decomposed.

Practically all of this soil type has been cleared of its native growth of oak, chestnut, and other hardwoods. At present some of it has a scattering second growth of hardwood with an undergrowth of chinquapin and other brush. Some fields, which the farmers consider "worn out," have been abandoned. The soil is especially adapted to wheat and clover, being the best in the county for these crops. It produces good crops of corn, potatoes, and cabbage and is excellent pasture land. Corn averages from 12 to 30 bushels, wheat 8 to 25 bushels, clover from 1 to 1½ tons, Irish potatoes 80 to 150 bushels, and cabbage 5 to 6 tons per acre. Even larger yields have been

secured by proper cultivation and fertilization. Apples and a few other fruits, sorghum, and vegetables are grown for home use.

On some areas of this type a little commercial fertilizer is applied, usually from 200 to 500 pounds per acre. Lime is used by some and beneficial results are always obtained. The Porters clay is a strong soil and one which can be highly and permanently improved. It needs to be plowed deeper and more thoroughly pulverized before planting. The growing of clover and cowpeas and incorporating of coarse manures in the soil would supply needed humus. When these green crops are plowed under it is best to add lime, both to correct the acidity and aid in their decomposition. The red clay knolls can be quickly reclaimed and made fairly productive in this way. Porters clay brings from \$20 to \$40 an acre.

Below are given the results of mechanical analyses of typical samples of the soil and subsoil of the Porters clay:

Mechanical analyses of Porters clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17839.....	Soil.....	3.0	4.9	2.2	18.2	4.3	41.6	24.9
17840.....	Subsoil.....	2.0	4.6	1.3	5.3	11.0	34.5	41.2

PORTERS SAND.

The soil of the Porters sand, to an average depth of 8 inches, is a yellowish-gray or gray, medium to coarse sand or light sandy loam. In many localities there are from 10 to 15 per cent of fine rock fragments in the soil, and occasionally a few granitic boulders are strewn upon the surface. The soil is quite similar in many respects to the lightest portions of the Porters sandy loam and might be considered as a phase of that type. The two differ, however, in agricultural value, topography, and in character of the underlying material. The subsoil is a yellowish to brownish sandy loam or sticky sand, which commonly grades into the disintegrated granite at 20 to 36 inches. In many places this weathered, soft, and crumbly rock comes within 8 inches of the surface and even outcrops frequently, and there is usually a gradation of the surface soil into the rotten rock. Throughout this soil there are small areas where the subsoil is a yellowish to red sticky sandy loam, and again spots of heavy sandy loam or clay are encountered.

This soil occurs throughout the roughest areas of the Porters sandy loam. The largest bodies of it are in the southern part of the county to the southwest of Flat Rock and to the southwest of Zirconia on Grassy and Pinnacle mountains. Many smaller bodies lie in the central and northeastern parts of the county.

The Porters sand usually occupies the mountain tops and steep slopes. In the Grassy Mountain locality it occurs in the plateau-like region. In the central part of the county it covers the crest of the low mountains and high ridges. The loose, open character of both the soil and subsoil, together with the topographic position, assures ready and excellent drainage. The rainfall runs off or drains through the soil immediately, thus giving a warm, early soil and one which can be handled soon after rains. The soil is subject to drought, especially where the rock comes near the surface. Many areas of this soil are badly eroded.

The Porters sand is derived from the Whiteside and Henderson granites. On the steep slopes the material has been removed nearly as fast as the rock has disintegrated and the finer soil material has accumulated only where the land is heavily forested or in coves and pockets. The partially decomposed rock outcropping in many places retains its original structure, and the quartz, feldspar, and mica particles are readily detected.

The greater part of this soil is forested with a native growth of post, white, and chestnut oak, a few scrubby pines, and hemlock. Laurel rhododendron, huckleberry, and chinquapin bushes form a dense undergrowth. The soil is too light and does not retain a sufficient amount of moisture for grain. Most of the type should remain forested or be used for pasture or apple orcharding. If manured or fertilized the soil is suited to early vegetables, berries, and potatoes. Peaches do fairly well, and several thrifty young apple orchards were seen. Orchards should not be set out where the bed rock comes within 3 feet of the surface. Only a very small percentage of the type is under cultivation, and unless manured or fertilized the yields are usually low.

Land composed of the Porters sand is held at \$5 and upward an acre.

The results of a mechanical analysis of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Porters sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17827.....	Soil.....	2.8	18.7	11.9	27.3	9.7	19.5	10.1
17828.....	Subsoil.....	3.7	20.2	12.4	29.3	9.9	13.5	11.2

PORTERS BLACK LOAM.

The soil of the Porters black loam, to a depth of 6 to 10 inches, is a very dark gray to black heavy loam or silt loam, containing a large amount of organic matter. In the coves the soil is black and mucky; the dark-gray or brown phase is found in the thinner forested areas.

Both soil and subsoil frequently contain considerable quantities of rock fragments. The subsoil varies from a dark grayish-brown to a yellowish-brown loam or clay loam and is frequently underlain by rock at from 20 to 30 inches. Where the heavy mucky phase of the type occurs the subsoil is much darker in color.

Only three small areas of this type are shown in the map. These occur in the extreme western end of the county between altitudes of 3,300 and 5,000 feet. Other small spots occur in the coves and on the tops of some of the high ridges, but these are of too small extent to be represented on the soil map.

In Henderson County this soil is derived from the Carolina gneiss. It may be regarded as a very fine textured phase of the Porters loam, which upon the addition of very large amounts of vegetable matter under moist conditions passes into the Porters black loam. The areas usually need drainage, which can be readily accomplished.

The forest growth on the Porters black loam is the same as that on the Porters loam. There is usually a dense undergrowth and in the moist places a heavy growth of ferns.

None of this soil is cleared or under cultivation in this county, and its present value depends upon the character of standing timber and its convenience to market. In other areas the soil is a valuable one for apples.

TOXAWAY LOAM.

The soil of the Toxaway loam, to a depth of 8 to 16 inches, is a dark-gray to black mellow loam or silt loam. The darker areas contain large quantities of organic matter. In some areas a dark-brown loam or silt loam is found; in others a brown, micaceous, very fine sandy loam. The subsoil varies from a dark-brown or yellow silt loam to clay. In some instances the first 6 or 8 inches of the subsoil is dark brown, grading into a brownish-yellow silty clay.

The largest areas of this type occur in the northwestern part of the county in the valleys of the French Broad and Mills rivers. Smaller areas are found along Boyleston Creek in the same section and along Earle Creek in the southeastern part of the county. Strips of less importance are found along many of the smaller streams.

The Toxaway loam occupies the level areas in the valleys of the French Broad and smaller streams. The greater portion of the type is nearly level, though where it occurs near the foothills it has a gentle slope. The areas bordering the rivers and larger creeks are occasionally subject to overflows that damage the crops to a considerable extent. The natural drainage of the level areas is poor, and open ditches are necessary and generally in use throughout the type.

This is an alluvial soil formed by the deposition in comparatively slow-moving water of the finer sediments brought down from the surrounding mountains. The material consists chiefly of clay, silt, and

very fine sand, frequently with large amounts of mica, washed down from the areas of loam and clay. A large part of this soil was formerly in a semiswampy condition, with a heavy growth of water-loving trees, shrubs, and grasses. The accumulation of large quantities of vegetable matter at that time has produced a dark mellow soil.

The typical growth upon this soil was elm and maple. At present practically all of the soil is under cultivation or in pastures.

The Toxaway loam is regarded as one of the most valuable soils in Henderson County, and is especially adapted to corn, grass (timothy and redtop), rye, and cabbage. Very good celery can be grown on many parts of it. Corn yields from 20 to 50 bushels an acre, hay 1 to 2 tons, and rye 10 to 22 bushels. Oats and wheat are grown to some extent, but they are not as profitable as the other crops mentioned.

On account of the level topography the cultural methods in use on this type are the best in the county, and much modern machinery is used. The application of lime to this soil is found to be very beneficial. Better results are obtained when applications of 15 to 20 bushels an acre are made at intervals of two to three years than when larger applications are made less frequently. A small amount of commercial fertilizer is used for corn, from 200 to 600 pounds per acre of a 2:8:2 mixture being used.

This soil brings from \$40 to \$75 an acre.

The results of mechanical analyses of the soil and subsoil of the Toxaway loam are given in the following table:

Mechanical analyses of Toxaway loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17841.....	Soil.....	0.1	0.6	1.0	13.6	7.8	48.2	23.6
17842.....	Subsoil.....	.0	.2	.6	12.4	5.8	37.5	43.0

TOXAWAY FINE SANDY LOAM.

The surface soil of the typical areas of the Toxaway fine sandy loam consists of a brown fine sandy loam to a depth of 8 to 12 inches. Scattered throughout this soil are small areas or narrow bands of fine loamy sand, medium to coarse brown sandy loam, and a few spots of gravelly sand or sandy loam. Patches of dark-brown silty loam occur in many places where the finer sediments have accumulated. Such patches usually contain more organic matter than the true type. No sharp line could be drawn between this type and the Toxaway loam, and small spots of the latter are not of infrequent occurrence. Again, the soil may be a fine sandy loam and the subsoil a heavy material resembling that of the Toxaway loam. The Toxaway fine sandy

loam is a mellow and very easily tilled soil and the surface allows the use of modern machinery.

The subsoil is a yellowish-brown fine sandy loam or fine micaceous sand. In a few areas the subsoil is a brown, dark-gray, or bluish loam, especially along some of the smaller streams. Mica scales in considerable quantity are present in both soil and subsoil in many localities. Most of this soil lies in the central and northwestern parts of the county, where it occurs as strips along the French Broad, Mills, and Green rivers, and also along Mud, Clear, and Cane creeks. A few narrow strips are located in the valleys of the smaller streams throughout the county.

The Toxaway fine sandy loam occupies level, flat, and very slightly undulating areas. Part of it is subject to overflow during freshets, but good crops can usually be secured. For the broader and more level areas artificial drainage is necessary, and this can be effected by open ditches. All of the type except a few very small spots can be drained and brought under cultivation.

This soil is of alluvial origin, being formed by the deposition of the coarser material which has been washed from the loam and clay areas and the finer material from the sandy loam and sand areas. It has been modified in certain places by the colluvial wash from the mountain sides, thus giving a soil quite variable in texture.

The greater part of this type is under cultivation, and the remainder is either covered with a forest of maple, elm, and white birch or is used for pasture. It will produce good corn, hay, wheat, and cabbage, and the sandier phase, melons and vegetables. Corn is the principal crop, the yield ranging from 15 to 50 bushels per acre. Grass (timothy and redtop) yields from 1 to 1½ tons, wheat 8 to 20 bushels, rye 10 to 20 bushels per acre. Cabbage, Irish potatoes, sorghum, oats, melons, and vegetables are grown to a small extent. Some of the farmers use a little commercial fertilizer and lime on this land. A rotation of grass, corn, and wheat is practiced by the best farmers.

Toxaway fine sandy loam sells for \$20 to \$50 an acre.

Below are given the results of the mechanical analyses of samples of the soil and subsoil of this type.

Mechanical analyses of Toxaway fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17843.....	Soil.....	0.4	0.6	0.7	44.4	20.2	20.8	12.5
17844.....	Subsoil.....	.2	3.5	7.6	19.0	15.0	35.0	20.4

MEADOW.

The soil of the areas mapped as Meadow varies greatly both in color and texture. The greater proportion of it consists of brown to dark-brown fine sandy loam with considerable quantities of micaceous material. In areas of poor drainage spots of a dark-brown mucky loam occur. Along the streams are bands of coarse and fine sand, sometimes containing considerable gravel. The subsoil varies from a sand or fine sand to a heavy sticky loam, usually dark brown in color.

The Meadow mapped in Henderson County lies to the southeast and east of Hendersonville along Mud Creek and Devils Fork Creek, and occupies level areas. The greater part of it is in a semiswampy condition and could be drained only at great expense.

The natural vegetation consists of a few maples and elms and water-loving bushes and grasses. While the Meadow is at present unsuited to the production of cultivated crops, it supports a heavy growth of wild grasses, which afford excellent summer pasturage.

ROCK OUTCROP.

The few small areas of Rock outcrop indicated on the soil map represent ledges on the sides of mountains or areas thickly strewn with large boulders. The most noticeable areas are the bald-faced cliffs on Pinnacle Mountain, Glassy Rock, and near Bat Cave. The Rock outcrop has no agricultural value.

SUMMARY.

Henderson County lies in the southwestern part of North Carolina. It is a typical mountain county, varying in elevation from 1,400 feet near Bat Cave to 5,000 feet on the western border. The French Broad and Green rivers and their numerous tributaries form the main drainage systems.

The county is sparsely settled, except in a few places near Hendersonville and in the French Broad Valley, the best developed regions, and a much larger population could be supported. Transportation facilities are supplied by the Southern Railway. Hendersonville, the county seat, is the largest town and principal market. Cabbage, potatoes, and some cattle are shipped out of the county.

Corn is the main crop. Hay, wheat, rye, cabbage, potatoes, fruit, and garden vegetables are secondary products. The production of apples and raising of cattle can be made profitable industries. There are large areas of forest land in the county. Lands range widely in value, from \$5 an acre for rough mountain land to \$75 an acre for the best improved farming lands.

The rocks from which the soils of Henderson County have been formed are mainly gneiss, schist, and shale west of the French Broad River, and granites, with some gneiss and schist, on the east side of this stream. There are eight distinct types of soil, five of which, of residual origin, belong to the Porters series. The remaining three are alluvial.

The Porters sandy loam has the most extensive development of any type in the county. It is best adapted to garden vegetables, potatoes, corn, rye, wheat, and fruits. The rougher areas should remain in forest.

The Porters loam, the next in area, occurs typically developed in the western part of the county in the mountainous section. Most of it is forested to hardwood. The rolling areas and foothills produce good crops of corn, rye, oats, potatoes, and cabbage. It is an excellent apple soil and also affords good pasturage.

The Porters clay occupies knolls and ridges and is well drained. It is the best soil in the county for wheat and clover. Rye, potatoes, and cabbage do well.

The Porters sand occurs on the mountain tops and ridges. It is a drougthy soil and only suited to light truck crops and fruit. The most of it should be kept in forest.

The Porters black loam occurs in a few spots in the high, shaded coves. None of it is under cultivation. It is forested to oak, poplar, and hemlock.

The Toxaway loam is the most productive soil in the county. It is especially adapted to corn, grass (timothy and redtop), and rye. Cabbage does well.

The Toxaway fine sandy loam is also a good corn, grass, and rye soil. Cabbage, potatoes, wheat, and vegetables make fair returns.

The Meadow comprises poorly drained alluvial soil lying along Mud Creek and Devils Fork east and southeast of Hendersonville. Its only use is for summer pasture.

SOIL SURVEY OF EDGECOMBE COUNTY, NORTH CAROLINA.

By W. EDWARD HEARN, assisted by G. M. MACNIDER, North Carolina
Department of Agriculture.

DESCRIPTION OF AREA.

Edgecombe County lies about the center of the northeast part of the State of North Carolina, being about 65 miles east of Raleigh. The county is bounded on the east by Martin County, on the north by Halifax County, on the west by Nash County, the Atlantic Coast Line Railroad forming the boundary, and on the southwest and south by Wilson and Pitt counties. The county is irregular in shape, and

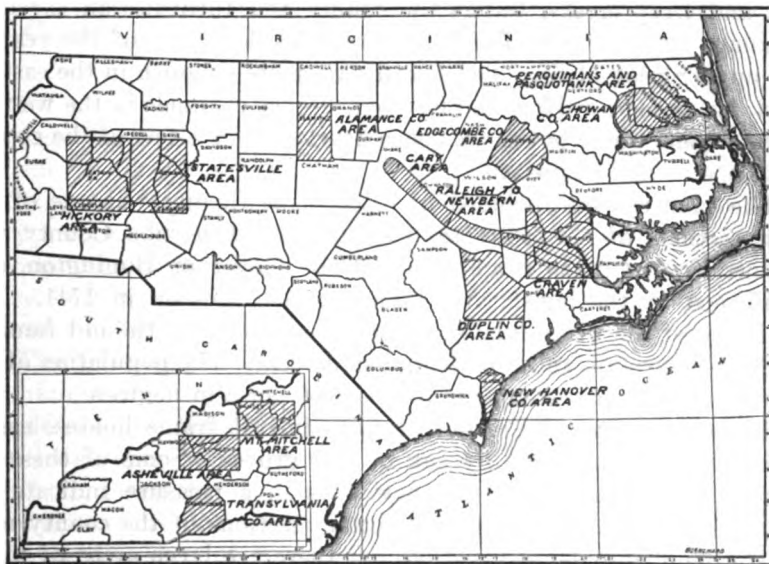


Fig. 7.—Sketch map showing location of the Edgecombe County area, North Carolina.

a little longer north and south than it is east and west. It contains 329,920 acres of land, or about 515 square miles. The Edgecombe County test farm of the North Carolina department of agriculture is located about midway between Tarboro and Rocky Mount, on the lower road about 2 miles south of Kingsboro.

The general surface features of Edgecombe County consist of level, undulating, and rolling areas intersected by a few strips of swamp following the streams. The main slope of the county is to the southeast, except along the eastern side, where it is to the southwest toward the Tar River. The broad level and undulating areas lie along the eastern border and in the southern and central parts, while the gently rolling and rolling areas occur as the western and southwestern parts of the county are approached. The more rolling areas are found adjacent to the swamps along the creeks and small streams. The surface of the county varies in elevation from about 35 feet on the Tar River in the southern part to 137 feet a few miles south of Rocky Mount. At Tarboro the elevation is 50 feet, at Leggett 63, at Pinetops 100, and at Rocky Mount 115.

The larger proportion of the county has good natural drainage. The Tar River enters the county just north of Rocky Mount, flows in an easterly direction, swings around Tarboro, and then pursues a southerly course out of the county. This stream, with its numerous tributaries, the chief of which are Fishing, Swift, Town, Otter, Cone-toe, and Deep creeks, waters the county and furnishes an excellent drainage system. The Tar River is navigable a part of the year as far up as Shiloh Mills. The streams are more sluggish in the eastern part, but become swifter and have cut deeper channels in the western part. Some water power was once developed on a few of the creeks, but none is used at present.

The country now included in Edgecombe County was one of the first sections of the State to be settled. Edgecombe County was formed from Craven County in 1733 by Governor Bunington, and confirmed by the legislature which met at Edenton in 1741. The majority of the white inhabitants represent some of the old families of North Carolina and are of English descent. The population of the county at present is composed of about 60 per cent negroes.

Throughout the county are many beautiful frame houses, neatly painted and surrounded by oak or elm groves. Some of these are antebellum houses, while the new ones in a measure indicate the county's present prosperity. In certain sections of the county most of the land is under cultivation, but there are large areas of undeveloped country east of Rocky Mount, in the eastern part along the Martin County line, and around Macclesfield. There is no waste land in the county save the few swamp areas. If all the arable land were intensively cultivated the county could easily support several times its present population, which is about 28,000.

Tarboro, the county seat, with a population of 5,000, located on the Tar River, in the center of the county, is the chief town. Rocky Mount, with a population of 7,000, is situated on the western side, partly in Edgecombe and partly in Nash County. Whitakers, Battle-

boro, Conetoe, Pinetops, Macclesfield, and Speed are towns of less importance.

The Norfolk branch of the Atlantic Coast Line Railroad crosses the county, passing through Tarboro, while the Plymouth branch of the same road runs southeast from Tarboro. The East Carolina Railway runs a little west of south through the county from Tarboro. The western boundary of the county is the main line of the Atlantic Coast Line. These roads afford excellent transportation facilities. During a part of the year a freight boat is operated on Tar River between Shiloh Mills and Washington, N. C. The dirt roads are being worked by convict labor, and most of them are in fairly good condition, except for the deep sand in a few localities. The county is well served by the rural free delivery of mail. There are good public schools in all parts of the county.

Tarboro is the chief market in the county for cotton, peanuts, and other farm produce. A large part of the tobacco is sold in Rocky Mount, but that grown in the southern part of the county is taken to Wilson. Most of the truck is shipped to the northern markets. A considerable quantity of cotton, peanuts, and other products is sold at Conetoe, Whitakers, and the other small towns.

CLIMATE.

The climate of Edgecombe County is characteristic of the climate of the middle Atlantic Coastal Plain. The winters are comparatively mild and the summers long and hot. December, January, and February are the coldest months, with an average temperature of 42° F. Occasional snows occur, but they are light and of short duration. The hottest months are July and August, with an average temperature of about 80° F.

The following table gives the normal and absolute maximum and minimum monthly and annual temperature and precipitation as recorded by the Weather Bureau observer at Tarboro. The normals are based upon records for eighteen years within the period August, 1871, to December 31, 1903—not continuous between the years 1875 and 1895. The dates of the first and last killing frosts are also shown. The average date of the last killing frost in the spring is April 13, and of the first in the fall October 24. This gives a growing season of 194 days for the tenderest crops.

Statistics of temperature and precipitation at Tarboro, Edgecombe County, N. C.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for driest year.	Total amount for wettest year.	Snow, average depth.
	°F.	°F.	°F.	In.	In.	In.	In.
January.....	41	78	- 1	4.0	4.4	3.6	1.9
February.....	43	76	- 2	4.0	5.4	3.6	3.1
March.....	51	91	13	3.7	2.7	3.9	.1
April.....	59	97	26	3.4	3.3	3.0	.2
May.....	69	99	37	5.2	2.1	5.6	.....
June.....	76	104	46	4.3	3.5	3.1	.....
July.....	80	105	48	6.3	2.0	11.6	.....
August.....	78	105	52	6.9	6.7	22.7	.....
September.....	72	106	36	3.7	1.0	2.0	.....
October.....	61	93	28	3.9	1.1	6.1	.....
November.....	51	87	16	2.7	3.7	1.9	Tr.
December.....	43	79	2	3.6	3.2	3.8	1.7
Annual mean.....	60	106	- 2	51.7	39.1	70.9	7.0

Dates of first and last killing frosts.

Year.	Tarboro.		Year.	Tarboro.	
	Last in spring.	First in fall.		Last in spring.	First in fall.
1890.....	Apr. 17	Nov. 5	1904.....	Apr. 22	Oct. 16
1900.....	Apr. 5	.....	1905.....	Apr. 18	Oct. 13
1901.....	Apr. 30	Nov. 7	1906.....	Apr. 3	Oct. 11
1902.....	Apr. 3	Oct. 30	Average.....	Apr. 13	Oct. 24
1903.....	Apr. 5	Oct. 27			

AGRICULTURE.

The agricultural products grown in Edgecombe County have been changed from time to time in order best to meet the varied and changed conditions. The first crops to be grown were corn, oats, and wheat. Hogs were raised for the home meat supply and a few cattle and sheep were also kept. In 1851 the population numbered about 16,000, the proportion of the races being as at present. Its products then were 5,000 bales of cotton, 715,000 bushels of corn, some oats, and wheat. Considerable wool was shorn. The turpentine industry flourished in those days. From 1851 to 1860 Edgecombe County made wonderful progress in agriculture, and the acreage of all crops was greatly increased. About twenty-five years ago some bright tobacco was grown, but it did not become one of the principal money crops until within the last fifteen years. Peanuts began to be grown on a commercial scale about ten or fifteen years ago. During the period between 1892 and 1897 the growing of tobacco assumed its

greatest importance. From the time of the civil war up to the establishment of the tobacco industry cotton had been the main money crop, but during years of depression following 1893 the price of cotton so declined that the farmers turned their attention to the production of bright tobacco. A warehouse was opened at Tarboro, but it was supported for a short time only. The peanut industry began to assume importance during the same period of low-priced cotton. Within the last six years, since the price of cotton has been comparatively high, the growing of tobacco has in many localities been abandoned for cotton and peanuts. The trucking industry, though developed as yet comparatively little, was taken up a few years ago.

For a number of years the people in Edgecombe County derived a large revenue from lumbering. The longleaf yellow pine and Savannah pine formed magnificent forests, and the sale of this timber added considerably to the support and wealth of a large percentage of the population. Practically all of this forest has now been cut, and only a few scattering areas of virgin timber are seen to-day. Some cypress and gum occur along the streams. Several small saw mills are in operation in different parts of the county.

At the present time the agriculture of the county is quite varied. Cotton is the staple and money crop; its yield for 1905 was 35,670 bales, and for 1906 it was 28,680 bales. Peanuts, both the Spanish and Virginia varieties, are recognized as an important money crop, and in some localities are partly taking the place of tobacco or are being rotated with cotton. The peanut vines make good hay when thrashed out.

Bright tobacco is grown quite extensively in the southern and western parts of the county, and also to a less extent in the northern part. It brings an average price of 8 to 10½ cents a pound. The price varies considerably, depending on quality, from 6 to 15 cents. Considerable money has been made from the production of this crop. About 7,000,000 pounds are annually sold at Rocky Mount. Corn is grown to a greater or less extent over the county and its acreage is gradually increasing. The main bulk of it is raised on the Portsmouth soils. Some truck crops, such as asparagus, cabbage, peas, and Irish potatoes, are grown around Conetoe, Tarboro, and in a few other localities. Several young orchards of peaches, a few pecans, and vineyards are found. Plantings of mulberries are also made in lots used as inclosures for hogs. Potatoes and garden vegetables are cultivated around every homestead. Only a small amount of sorghum is raised. Cowpeas and crimson clover are grown. Many hogs, a small number of cattle, and a few sheep are raised. Large quantities of hay and corn, as well as meat, are bought at high prices and used in the county. These products should be grown in sufficient quantities for home use.

It is generally recognized that the Portsmouth soils, or what are better known locally as the "swamp lands," are well suited to the production of corn, and a few of the higher and better drained areas of these types to cotton. Peanuts are grown on the more sandy soils of each farm. Practically all of the tobacco is grown upon the Norfolk fine sandy loam and Norfolk sandy loam. The truck crops are confined to the lighter and warmer areas of the Norfolk sandy loam and Norfolk fine sandy loam and the sands of this series, except some of the cabbage, which is grown on the Portsmouth sandy loam. The peach trees and grape vines have for the most part been planted upon the knolls and well-drained areas. In many localities all of the above-mentioned crops are grown upon the same type of soil without regard to its adaptability.

The farmers in Edgecombe County are fortunate in having established a number of paying agricultural industries, offering the best possible opportunities for the changing of crops to suit economic conditions, as well as for the introduction of systematic and profitable crop rotations. Some have already departed from the one-crop system earlier in vogue and alternate two years of cotton with one of peanuts. Others rotate cotton with peanuts, one year of each, except for an occasional crop of corn. A fairly practicable rotation to follow would be cotton, peanuts, and corn, sowing cowpeas at last plowing.

On some of the large plantations the agricultural methods in practice are good, but on many of the smaller farms and even on some of the plantations where the tenant system is followed there is room for considerable improvement. The Norfolk sand and Norfolk fine sand are so loose that shallow plowing gives fairly good results. The Norfolk sandy loam, Norfolk fine sandy loam, and the Portsmouth soils are not in many cases plowed to a sufficient depth and not properly pulverized before the seeds are planted. The surface features, coupled with the mellow character of the soils, permit of the use of modern machinery. A great variety of improved labor-saving machinery is now in use. Cotton planters, fertilizer distributors, peanut and corn planters, sulky plows, and horse cultivators are common. Peanuts are thrashed out by machines. Tobacco transplanters could well be introduced, especially where a large acreage is devoted to that crop.

Most of the labor is of the colored class, many women being employed in the fields. The cost per month is about \$12.50 with rations, or \$16 without. Day laborers receive from 60 to 80 cents a day. The wage-earners in general aim to become tenants as soon as possible.

The large plantations are generally operated by a manager who hires labor and carries on the farming operations or superintends the tenants. An extensive tenant system is developed especially around

Tarboro. Many of the wealthy farmers live in Tarboro and rent their farms for a part of the crop. Under this system the landowner furnishes the land, stock, feed for stock, implements, seed, and one-half of the fertilizer, and receives one-half of the crops produced. A large number of farms in the southern and southwestern, and sections in the northern part are operated by the owners. Some farms are rented for one-third of the corn and cotton, and a few for a stated amount of lint cotton.

The farms vary greatly in size, the larger ones containing from 500 to 1,200 acres or more, and the smaller ones about 100 acres. The latter are found chiefly in the southern and northern parts of the county. There are large tracts of undeveloped land, from which the merchantable timber has been cut during recent years and which are now covered by a few scattering pine, old field pine, and old stumps.

Some of the land in the county can be bought for \$15 to \$30 an acre, but most of the developed land with improvements is held around \$50 and some of the land near Tarboro and Rocky Mount would sell for \$100 an acre. There is not much land being advertised or changing hands. Land in this county has increased in value greatly within the last ten years.

Edgecombe County contains one of the test farms of the North Carolina department of agriculture. The results obtained at this farm in fertilizer trials and variety tests should be very beneficial to the farmers of this section, as the farm is located upon one of the large soil types, the Norfolk sandy loam, with a spot of Norfolk fine sandy loam and Portsmouth sandy loam.

Most of the soils in the county should be plowed deeper and more carefully pulverized before the seeds are planted. A considerable increase in yields could be obtained by proper spacing of plants in rows and by using improved selected seed. A full stand is one of the requisites towards securing a full crop. A rotation of crops so as to include a forage crop should be practiced. Dairying, poultry raising, and trucking offer opportunities for profitable investments. More attention should be given to the needs of the soil as regards just the sort and quantity of fertilizer that the several crops require for their best development. The Norfolk types especially would be greatly benefited by coarse manures and green manuring crops, followed by lime.

SOILS.

Edgecombe County lies in the western part of the Atlantic Coastal Plain. The entire area is covered by the Columbia formation, but in the western part of the county the Columbia forms only a superficial covering and the dominating features of the topography and soils are those of the older or Lafayette formation. The eastern part of the

county is an almost level unbroken plain, but going westward the county becomes more rolling, the streams cut deeper channels, forming well-defined terraces, and as the falls of the Tar River are approached the whole surface of the country presents the aspect of an older geological formation.

The materials of which these two formations are composed were brought down from the Piedmont section and deposited while the present area was a part of the sea floor. These sediments have since been more or less altered by stream and organic agencies. Underlying many areas, particularly along the Tar River and the smaller streams, are extensive beds of shell marl at from 6 to 50 feet below the surface. These marl beds are principally of the Eocene and Neocene age and are very rich in carbonate of lime, occasionally containing considerable percentages of calcium phosphate. At one time the marls were the principal source of agricultural lime.

Along the western border of the county there are several outcrops of the older underlying crystalline rocks. These outcrops are small in extent and have had no more than a very local effect upon the soils.

The soils derived from the sediments are sandy loams or clays and sands of varying degrees of texture. In the eastern part of the county they are largely fine sandy loams with bright yellow sandy clay subsoils, typical of the materials of the Columbia formation. After the center of the county is passed the coarser materials become more prevalent, and in the western part of the county the soils are sandy loams with dark orange or reddish-yellow sandy clay subsoils, typical of the sediments of the Lafayette formation. Stream and road cuts in the west-central and western parts of the county afford many sections of the brick-red material of the Lafayette. This material is in many instances stratified and always contains a large quantity of rounded quartz gravel, varying in size from fine gravel to fragments an inch or more in diameter.

The soils of the county are typical Coastal Plain soils, and have been classified in two distinct series, the Norfolk and the Portsmouth. The Norfolk series comprises the light-colored upland soils, with yellow or orange sand or sandy clay subsoils. The Portsmouth series comprises the dark-colored soils of the lowlands, with gray or mottled gray sandy clay subsoils.

The soils of the Norfolk series occupy the greater proportion of the county and have been classified according to their texture into four types, viz, fine sandy loam, sandy loam, sand, and fine sand.

The soils of the Portsmouth series are derived directly from the same kind of material as the Norfolk series by the addition of organic matter. They occupy the lowlands around the streams, have very little drainage, and have been for a long time in a semiswampy condition which has favored the accumulation of very large quantities of

vegetable matter. This gives them their dark color and mainly distinguishes them from the light-colored soils of the Norfolk series. Three soils of this series have been mapped in this county, viz, sandy loam, fine sandy loam, and loam.

The following table gives the extent of each of the several types of soil mapped:

Areas of different soil types.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Norfolk fine sandy loam.....	150,912	45.8	Portsmouth sandy loam.....	5,056	1.5
Norfolk sandy loam.....	117,440	35.6	Norfolk fine sand.....	4,608	1.4
Swamp.....	23,424	7.1	Portsmouth loam.....	896	.8
Norfolk sand.....	16,192	4.9	Total.....	329,920	-----
Portsmouth fine sandy loam.	11,392	3.4			

NORFOLK SAND.

The Norfolk sand is a light-gray, yellowish, or light-brown coarse to medium sand having an average depth of about 6 or 8 inches. It is porous, loose, and incoherent, and it contains a considerable quantity of small rounded gravel in a few of the areas along the river. The darker colored areas are those which have been heavily manured or never denuded of their forest growth, while the light-gray, and in spots whitish areas, have been badly leached. The soil of this type is very easily tilled.

The subsoil, to a depth of 36 inches or more, is a yellow, loose, incoherent coarse to medium sand. Occasionally a sticky sand or sandy loam is encountered at 30 to 36 inches. In a few places small rounded gravel are also present in the subsoil.

Most of the Norfolk sand is found in the southeastern and central parts of the county around Conetoe, Dogtown, and along the Tar River. Some isolated areas, however, occur along Fishing Creek in the northern part of the county and along Town Creek in the southern part.

This soil occupies gently rolling areas, ridges, and knolls. It is commonly a few feet higher in elevation than the surrounding soils, except when it occurs as the first bottom land along the streams. In the southeastern part it forms low ridges and knolls scattered indiscriminately throughout the Portsmouth types and along the Tar River. Owing to its coarse texture and slightly rolling position the natural drainage of this soil is excellent. Some areas are so excessively drained that the soil suffers seriously from drought. Farming operations can be successfully carried on immediately after heavy rains.

The Norfolk sand represents the coarser material of the Columbia formations in this county. Evidently some of these areas of sand

have been modified by stream action, while the finer particles from all areas of it have been washed out, leaving the coarse sand and fine gravel. Some of the coarser phase of this type is rather unproductive.

The forest growth on this soil is chiefly old field pine, together with a few shortleaf pines and scrub oaks. This soil is not adapted to general farming and should be devoted to growing early truck crops, grapes, pecans, peaches, mulberries, watermelons, and potatoes. A considerable part of the type is under cultivation, but the yields of corn and cotton are light, except when the soil is heavily fertilized. Cotton produces from one-fourth to two-thirds of a bale per acre; peanuts give fairly satisfactory returns, probably better than any other of the staple crops. Some truck, Irish potatoes, sweet potatoes, and peaches are grown. A large pecan orchard is located on this type in the northern part of the county.

The Norfolk sand is worth about \$10 to \$30 an acre. It can be wonderfully improved by coarse manures and by turning under green manuring crops such as cowpeas and vetch, and by applying a little lime. The manures will not only increase the humus content of the soil, but will also make this porous sand more loamy and more retentive of moisture.

The average results of the mechanical analyses of fine-earth samples of this type are shown in the following table:

Mechanical analyses of Norfolk sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16637, 16639.....	Soil.....	2.3	26.5	21.7	35.5	2.8	6.3	4.8
16638, 16640.....	Subsoil.....	2.9	28.4	20.9	35.1	3.1	5.6	3.7

NORFOLK FINE SAND.

The Norfolk fine sand is a gray, pale-yellow, or light-brown fine sand to a depth of from 5 to 8 inches. It is loose and incoherent when dry, but slightly loamy when wet. Spots of it are whitish in color, owing to the fact that cropping has practically depleted such areas of organic matter. The soil is mellow, being composed of fine rounded sand particles and only a very small percentage of clay. It is doubtless the most easily tilled of any soil in the county.

The subsoil to a depth of 36 inches is a yellow, orange-yellow or light-gray fine mellow sand, usually loose and incoherent. In a few localities and especially along the contact between this type and the Norfolk fine sandy loam the subsoil becomes sticky at 30 to 34 inches and passes into a yellow fine sandy loam.

The Norfolk fine sand occurs in small isolated areas in the south-central part of the county. The largest of these areas lie along Town Creek and west of the Tar River on the Tarboro and Old Sparta road and directly west of Tarboro. A few very small spots of this soil were mapped in the eastern and southern parts of the county.

This soil occupies gently rolling and undulating areas, usually slightly higher than the surrounding soil types, which moderately inclined character of surface, together with the loose, open character of the soil, insures good drainage. It is a warm, well-drained soil and can be tilled soon after a rain.

The Norfolk fine sand is sedimentary in origin, being derived from the finer sands of the Columbia formation. Most of the silt and clay originally in the material has been carried away in the drainage waters, leaving the fine sand. There is only a small proportion of organic matter present, except in a few of the more densely forested areas.

Most of the uncultivated areas of this soil are forested to shortleaf pine, old field pine, some scrub oaks, dogwood, and sweet gum. The soil is too light for general farming, but it is admirably suited to early truck crops, such as peas, beans, radishes, lettuce, and to Irish potatoes and Scuppernong and Mish grapes. Of the staple crops peanuts and potatoes give best returns.

The yields of cotton range from one-fourth bale to 1 bale per acre, the latter yield being obtained only when good cultivation is practiced and when large quantities of fertilizer or manure are applied. Peanuts yield from 30 to 60 bushels per acre, corn makes small yields, while Irish potatoes, sweet potatoes, grapes, peaches, cabbage, and berries give fair returns.

The truck crops and cotton are usually heavily fertilized, while a lighter application is given to peanuts and corn. The Norfolk fine sand is a valuable early truck soil. It can be improved greatly by coarse manures and by plowing under green manuring crops, after which the soil should be dressed with lime. This treatment would not only add the needed humus to the soil, but would improve the texture and moisture conditions as well.

The following table gives the results of mechanical analyses of the soil and subsoil of the Norfolk fine sand:

Mechanical analyses of Norfolk fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16641.....	Soil.....	0.5	4.3	5.1	64.7	13.5	8.3	3.6
16642.....	Subsoil.....	.5	3.3	3.5	63.3	15.8	7.6	5.3

NORFOLK SANDY LOAM.

The Norfolk sandy loam consists of a gray to yellowish-gray medium to coarse sandy loam, varying in depth from 6 to 24 inches, with an average depth of about 12 or 15 inches. Below the first 5 or 6 inches of soil there is a stratum of yellow medium to coarse sandy loam. In a few places in the western part of the county along the Tar River the soil is brown in color, contains a few river gravel, and is more variable in depth and texture than the typical areas. In a few localities there are spots of coarse sandy loam containing from 5 to 15 per cent of small quartz gravel. Occasionally in the more rolling areas the sandy surface soil has been washed off, leaving the reddish-yellow subsoil exposed. The soil is cultivated with ease and its position allows the use of modern machinery, except on a very few of the steeper slopes near the streams.

The subsoil for the larger and more uniform areas of the type is a yellow sandy clay, the sand particles being coarse to medium. Along the Tar River, in the western part of the county, and in a few other localities, the subsoil varies from the typical yellow sandy clay to a brown sandy loam, and in spots to a red clay loam.

The Norfolk sandy loam comprises the greater proportion of the western, west-central, and northwestern parts of the county, and large areas throughout the east-central part. The largest continuous areas are found on the Edgecombe-Nash line between Rocky Mount and Kingsboro, and to the east of Battleboro and Whitakers. Other prominent bodies lie along the Tar River around Tarboro and Old Sparta, and strips along Town Creek. Smaller areas of it occur in the southeastern part of the county. The Edgecombe County test farm is located upon this soil type.

This soil type possesses the widest range in topography of any soil in the county, occupying as it does the level to rolling areas and occurring in both the lowest and highest positions. It ranges in elevation from 40 feet in the southeastern part of the county to 137 feet in the western part. The large level to gently rolling areas are found between Rocky Mount and Kingsboro, around Tarboro, and east of Battleboro and Whitakers. The rolling areas of the type occur chiefly in the western and southern parts of the county as strips lying between the Norfolk fine sandy loam and the Swamp, and along the streams in the northern part. It is the most rolling soil in the county, and a few spots of it are eroded to a noticeable extent. All the rolling and undulating country covered by this type is well drained, and only the level areas need artificial drainage. Such areas, however, can be readily drained by open ditches.

The Norfolk sandy loam is sedimentary in origin and is derived for the most part from the Columbia sands and clays. On the steeper

slopes and more rolling areas the material has been subject to considerable washing and the rain waters have carried away a large amount of the finer material, leaving a light sandy loam, while on the more level areas the soil contains a larger proportion of clay and is slightly more compact. In the west-central part of the county the Lafayette formation of sands and clays is capped by the Columbian material and where the streams have cut down a few feet the red sandy clay with rounded quartz gravel is exposed. Along the Tar River, near the Edgecombe-Nash line and for a few miles to the east there outcrops some granitic rock in spots, and the soil in these places is probably modified by the residual products from this granite, as the subsoil is a red clay loam.

The forest growth at present is loblolly and shortleaf pine, with a few scrub oaks and other hardwoods. There remains only a small quantity of merchantable timber. This soil is well suited to late truck, cotton, bright yellow tobacco, peanuts, grapes, and potatoes. Cowpeas do well, and crimson clover and alfalfa can be grown.

The yield of cotton ranges from one-third bale to $1\frac{1}{4}$ bales per acre; tobacco from 500 to 1,000 pounds; peanuts 50 bushels of the Spanish or 75 bushels of the Virginia variety; corn from 12 to 20 bushels. Some truck is grown around Conetoe and in other localities, with a marked degree of success. A few Irish potatoes, sweet potatoes, peaches, grapes, and mulberries are grown. Several small fields of crimson clover were seen and also a patch or two of alfalfa. Cowpeas give good returns, but are only grown to a limited extent. Practically all the crops on this soil are fertilized, but the tobacco, cotton, and truck crops receive the heaviest applications. Many farmers use the standard brands found in the market, while on a large number of the more extensive plantations they use a home mixture of cotton-seed meal, kainit, and acid phosphate. This soil holds manures fairly well and is capable of being maintained in a state of high productiveness. Cowpeas plowed under, and manure and lime, added together, with a systematic rotation of crops, would soon cause this soil to produce good yields without the use of so much commercial fertilizer. Deeper plowing, better preparation of the soil, and more thorough cultivation would also increase the yields. Land of this type sells at \$15 to \$50 an acre, and some of it near Tarboro and Rocky Mount is held at even higher prices.

The following table gives the average results of mechanical analyses of samples of this soil type:

Mechanical analyses of Norfolk sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16645, 16647.....	Soil.....	4.7	25.7	14.6	20.1	7.1	20.7	6.7
16646, 16648.....	Subsoil.....	2.8	22.7	12.2	17.4	6.9	15.3	22.3

NORFOLK FINE SANDY LOAM.

The surface soil of the Norfolk fine sandy loam consists of a gray or yellowish-gray mellow fine sandy loam ranging in depth from 6 to 30 inches, with an average depth of 10 to 15 inches. Between the gray surface soil and the yellow sandy clay subsoil there is a yellow fine sandy loam. Spots of dark-gray soil are sometimes found in the forested areas, while in the areas which have been cultivated for a long time and lightly manured the soil is lighter in color. Immediately west of Pinetops and in other level areas the soil is a very fine sandy to silty loam and is more compact than in the typical areas. Near some of the streams and on the slopes a small proportion of rather coarse particles are present. The soil is very easily tilled and suited to the use of all kinds of labor-saving machinery.

The subsoil to a depth of 3 feet or more is yellow sandy clay, the sand particles being fine. There are some places where the subsoil is a reddish-yellow to red sandy clay, and in other places a yellow clay loam sometimes streaked with red or purple is found.

The Norfolk fine sandy loam has the greatest development of any soil in the county. Large continuous areas occur along the Edgecombe-Martin line, and in the central and southwest parts of the county. Smaller areas and isolated bodies are scattered throughout the remaining parts of the county. It is typically developed east of Coakley, around Speed and Lawrence, to the east of Gethsemane, and along the East Carolina Railway in the vicinity of Henrietta, Pine-tops, and Macclesfield, and around St. Lewis and Lancaster.

The surface features of this type vary from high flat and undulating to rolling areas. It ranges in elevation from 40 feet in the southeastern part of the county to 128 feet at Lancaster. The broad flat areas are found on the eastern side and in the northern part of the county and around Pinetops, south of Macclesfield, near Lancaster, and east of Crisp. The surface of this soil becomes rolling as the streams are approached, and the more rolling areas lie around Lawrence and in the central part of the county. On a few of the steepest slopes the soil washes and low terraces are sometimes necessary. The

undulating and rolling areas have good natural surface drainage. The flattest areas have to be drained artificially, but this can be accomplished quite effectively by canals and open ditches leading into the natural drainage ways. The banks stand up well, thus insuring considerable permanency.

The Norfolk fine sandy loam is derived from the Columbia formation, but has been modified to some extent by erosion. In the western part of the county this type, and especially the subsoil, has been influenced by the underlying Lafayette formation, which gives a reddish sandy clay subsoil. On the rolling areas an appreciable quantity of the silt and clay has been carried away in suspension and a light, loose soil is left, while on the flat areas the soil is a mellow fine sandy loam containing considerable silt.

This soil type was once forested with longleaf pine and the Savannah pine. However, most of the merchantable timber has been cut, and only small lots now remain. Where the land has been allowed to reforest itself a thick growth of loblolly or shortleaf pine and a few scrub oaks have come up. A large proportion of this soil is still undeveloped. The Norfolk fine sandy loam is one of the best general-purpose soils in the county, being suited to a diversity of crops and especially adapted to late truck, peanuts, bright tobacco, and cotton. Potatoes, peaches, grapes, crimson clover, cowpeas, and alfalfa can be successfully grown. Cotton produces from one-third bale to 1½ bales per acre, the latter yield being attained with very heavy fertilization. Tobacco yields from 500 to 1,200 pounds, corn from 10 to 25 bushels, peanuts from 30 to 60 bushels of the Spanish nut and from 50 to 100 bushels of the Virginia nut; potatoes, cabbage, and garden vegetables do well on this soil, and also peaches and grapes. Cowpeas yield well and crimson clover is grown to a limited extent.

Of the complete commercial fertilizer the 2:8:2 grades are extensively used, but there are also some brands of 3:8:3 grade in favor with the planters. Many of the best farmers mix cotton-seed meal, acid phosphate, and kainit. A little lime is occasionally applied to this soil. From 200 to 600 pounds of fertilizer to the acre is commonly used for cotton, while from 400 to 1,000 pounds is applied to the tobacco fields. Peanuts and corn are not so heavily fertilized.

The Norfolk fine sandy loam is susceptible of high improvement and a few are realizing it. The soil will be greatly improved by applying coarse manures, plowing under pea-vine stubble, vetch, or clover, and applying lime. A systematic rotation of crops, together with better and deeper preparation of the soil and more thorough cultivation, will be found profitable. Especially after turning under a considerable quantity of green manure, it would be well to give the land a moderate application of lime. This soil ranges in price from

\$15 to \$50 an acre, depending upon the location and transportation facilities.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16649.....	Soil.....	0.6	2.5	5.0	55.9	15.2	15.0	6.4
16650.....	Subsoil.....	.1	1.9	3.8	50.3	13.8	12.8	17.5

PORTSMOUTH SANDY LOAM.

The soil of the Portsmouth sandy loam to a depth of 6 to 15 inches is a dark-gray or black medium to coarse sandy loam. The dark-gray phase is usually under cultivation, the heavy black phase occurring in the thickly forested and poorly drained areas. In a few localities, particularly along the Tar River, the soil contains a considerable amount of gravel.

The subsoil is a light to dark-gray sandy clay mottled with brown. In some areas the subsoil consists of a dark-gray coarse sandy loam, while in others it is a dark-brown mucky sand or sandy loam.

This type is confined largely to the southeastern part of the county, the largest areas occurring along the railroad between Mildred and Conetoe. Small strips occur along White Oak Swamp in the northern part of the county and Cokey Swamp in the west-central part. A few acres are found along the Tar River. Along Tar River and the smaller streams the soil occupies level and depressed areas, and many areas are in a semiswampy condition. Artificial drainage is necessary throughout the type, the usual method—large central canal with side ditches through the fields—being in use.

The Portsmouth sandy loam is composed of the coarser materials of the Columbia formation, which in the areas bordering the streams, particularly along the Tar River, have been modified by stream action. To this material has been added, through the swampy condition to which the type has been subjected, a relatively large quantity of organic matter.

On the more elevated portions of this type a few loblolly pines are found, but the typical vegetation is black gum and poplar, with cypress in the swampy areas, always with a thick undergrowth of reeds and other swamp vegetation.

This soil is very well adapted to corn and, when well drained and limed, to cotton and oats. Corn is the principal crop; from 200 to 500 pounds of rock lime to the acre are used and the yields vary from

20 to 50 bushels, averaging about 30 bushels per acre. A small quantity of cotton is grown, and when the land is well limed and a little commercial fertilizer used the yields vary from one-half to 1 bale per acre. This type is held at a rather high price on account of its value as a corn soil.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Portsmouth sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16655.....	Soil.....	1.7	7.4	10.4	34.5	17.5	16.1	12.8
16656.....	Subsoil.....	1.4	7.3	9.9	34.1	17.4	11.7	18.8

PORTSMOUTH FINE SANDY LOAM.

The soil of the Portsmouth fine sandy loam consists of a light to dark gray fine sandy loam varying in depth from 6 to 15 inches. In the heavily forested areas the soil is black and very heavy, while in the depressed areas, where there is always considerable water, the soil to a depth of 6 or 8 inches is a brown mucky material.

The subsoil of the typical phase of this type is a gray fine sandy clay mottled with yellowish brown. In the depressed areas the subsoil is heavy and contains a large amount of silt. In other areas where there is a large proportion of sand in the soil the subsoil consists of a gray or brown sticky fine sand.

The greater proportion of this type occurs in the southeastern part of the county. The largest areas are found west of Mildred, east of Dogtown, and east of Piney Grove. Small strips occur along the streams in the eastern part of the county separating the Swamp areas from the soils of the Norfolk series. Less important areas are found along the streams in the northeastern part of the county.

The Portsmouth fine sandy loam occupies level areas at elevations of about 50 feet. Slightly higher elevations are found along the streams in the eastern part of the county. The natural drainage is in all cases very poor, but good artificial drainage can be secured on most of the areas by a system of open ditches.

This soil is composed of the finer sediments of the Columbia formation to which have been added large amounts of organic matter, thus bringing about its present condition. A few small areas of medium sandy loam were found along some of the streams, but these are not of sufficient size to be represented on the map.

The higher, better drained areas are forested to loblolly pine and scrub oak, while on the poorly drained swampy areas the typical swamp forests of gums and cypress are found.

This soil is well adapted to corn and the better drained areas to cotton and peanuts. While no truck is grown at present, it would probably make a very good soil for late truck, such as cabbages, potatoes, and other vegetables requiring a moist soil. Corn is the principal crop grown on this type; the land is well limed and the yields vary from 20 to 30 bushels per acre. A little cotton is grown on the lighter phase; with liberal applications of lime and a small amount of commercial fertilizer from one-third to 1 bale per acre is the usual yield. A few peanuts are grown on the better drained areas.

On account of its value as a corn soil, this land is held in high esteem and is valued at from \$30 to \$40 an acre.

The following table gives the results of mechanical analyses of a sample of the soil and subsoil of this type:

Mechanical analyses of Portsmouth fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16657.....	Soil.....	0.8	6.7	8.3	27.0	14.5	28.8	14.2
16658.....	Subsoil.....	1.3	5.8	7.2	21.4	12.1	22.3	30.5

PORTSMOUTH LOAM.

The Portsmouth loam consists of a dark-gray to black heavy loam, varying in depth from 10 to 20 inches. It contains a relatively large proportion of organic matter and is a mellow, easily tilled soil. In a few instances there is a considerable quantity of fine sand in the soil, but in the greater part of the areas lying next to the swamps the soil contains an unusually large amount of organic matter and closely resembles a muck. The subsoil is a heavy silt loam, clay loam, or very fine sandy clay, in color dark gray mottled with brown. In the deeper phases the subsoil is only slightly lighter in color than the soil and is composed of a heavy fine sandy clay.

This soil occupies a very limited acreage, a few small areas being found in the eastern and southeastern parts of the county. The largest of these occur northeast of Conetoe, southeast of Shiloh Mills, and west of Piney Grove.

The Portsmouth loam occupies low-lying, level or depressed areas, frequently adjoining or surrounded by swamp. Some of the areas near the large swamps are frequently flooded and are in a semi-swampy condition during a greater part of the year. The drainage of the few areas under cultivation is effected by large open main ditches with a number of smaller laterals.

The Portsmouth loam is derived from the finer sediments of the Columbia formation. Its topographic position and semiswampy

condition have favored the accumulation of very large quantities of organic matter, which has been largely the factor in distinguishing this soil from the soils of the Norfolk series.

The greater proportion of this type is forested with black gum, sweet gum, poplar, and a few pines, with cypress on the wetter areas. There is always a heavy undergrowth of reeds, vines, and other swamp vegetation.

This soil is especially adapted to corn, and the heavier phase, when properly drained, would probably grow good onions and celery. Lime is practically the only fertilizer used, the yield of corn on well-limed soil being from 30 to 50 bushels per acre. Very little of this soil is at present under cultivation, but when cleared and properly drained it will be a very valuable soil for the production of corn and hay.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Portsmouth loam:

Mechanical analyses of Portsmouth loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16650.....	Soil.....	0.5	4.5	5.6	20.8	11.2	27.6	28.8
16660.....	Subsoil.....	.5	2.9	5.1	24.5	7.4	25.7	34.2

SWAMP.

The areas mapped as Swamp consist of the low-lying land that is always very wet, a large proportion being flooded during part of the year. The soil to a depth of 6 to 20 inches is a dark-brown or black muck or heavy loam, composed largely of decomposing vegetable matter mixed with a small amount of silt and clay. The subsoil is usually lighter in color than the soil, but varies greatly in color and texture in different areas. In some instances it is a heavy gray silty clay mottled with brown, while in others it is a dark-brown mucky sand. Along the Tar River there are a few areas mapped as Swamp that do not come under this head, but which can not be classified with any one of the soil types. These areas occur in the oxbows of the river and are composed of a heavy brown silty loam of uniform color and texture. These areas would be very valuable were it not for the fact that they are frequently flooded by the river.

The Swamp areas occur generally along the streams throughout the county, and vary in width from a narrow strip along the smaller streams to one-half mile or more along the larger ones. The largest areas are found along Fishing, Swift, Town, and Conetoe creeks, Cokey Swamp, and Tar River, and small isolated spots are found throughout the county. All of the Swamp areas are thickly forested

with cypress, black gum, and other water-loving trees, beneath which occurs a thick undergrowth of reeds and vines. On the driest areas a few pines are found. Practically all of the merchantable timber has been cut from the swamps. Many areas of these swamp lands could be drained very cheaply and these when cleared would make excellent pasture land during the summer months.

SUMMARY.

Edgecombe County—area 329,920 acres or about 515 square miles—lies in the northeastern part of North Carolina. Its topographic features vary from broad level to gently rolling and rolling areas. The general slope of the surface is toward the southeast, the elevation ranging from 137 feet in the western part to about 35 feet on Tar River at the southern boundary. The regional drainage of the rolling sections is good and the county is well watered by the Tar River and its numerous tributaries.

The county is well situated as regards transportation facilities. It is served by the main line and two branches of the Atlantic Coast Line Railroad. The East Carolina Railway, running south from Tarboro, has opened up a good country. Fairly good dirt roads are found, and these are steadily being improved.

Good public schools, churches, and the rural free delivery of mail are found throughout the county.

Tarboro, the county seat, is the principal town. Rocky Mount, situated on the western boundary of the county, is a progressive town of large business interests. Several smaller towns and shipping points are conveniently located along the railroads. These furnish good markets for cotton, tobacco, peanuts, and other farm products.

The climate is mild. Slight freezes occur during the winter, but are of short duration. The summers are usually long and hot. There is a comparatively long growing season, thus affording opportunity for the production of a wide range of crops, and in many cases for two or more crops in one season from the same field.

Edgecombe County was one of the leading agricultural counties in North Carolina before the civil war, and it has maintained that reputation to the present time. In relation to area it is one of the largest cotton-producing counties in the State. It grows a fair quality and a large quantity of bright tobacco. The peanut crop is also important, and some trucking is carried on profitably. Large quantities of commercial fertilizers are used in growing these crops.

Upon most of the large plantations and on some of the small farms are seen neat frame houses and other improvements, which indicate a prosperous condition of the farming class.

A great variety of improved farm machinery is used in Edgecombe County, and the character of the surface makes the use of most labor-saving machinery advantageous.

An extensive system of tenant farming has been developed. Labor is principally colored. The ordinary laborer receives about \$16 a month.

Land values have been increasing steadily and in the last few years rapidly, owing to the ruling high price of cotton. Still there are areas of undeveloped land throughout the county to be had at very reasonable prices, which will give good crops and support a greatly increased population.

The soils of Edgecombe County are derived from the Columbia formation of sands and clays, modified to a slight extent in the western part of the county by the materials of the Lafayette formation. The weathering of these sands and clays has given rise to two distinct soil series, viz, the Norfolk series and the Portsmouth series.

The Norfolk series represents the lighter colored, better-drained soils, while the Portsmouth series are darker in color, contain more organic matter, and are naturally deficient in drainage. The Norfolk soils cover practically all of the county except a portion of the southeastern part.

The Norfolk fine sandy loam occupies the largest area. It is a mellow, easily tilled soil, and one suited to practically all of the crops of the region except corn. Large areas of this type in the southern and northern parts of the county are undeveloped. It is especially adapted to bright tobacco, peanuts, late truck crops, and, when fertilized, to cotton.

The Norfolk sandy loam differs from the Norfolk fine sandy loam mainly in texture, but partly in the character of the topography. It is coarser, a little better drained, and truck matures a little earlier on it. It is a good cotton, tobacco, and peanut soil.

The Norfolk sand and Norfolk fine sand are loose, porous, well drained, and warm soils. They can be cultivated immediately after a rain. In dry seasons they are droughty and crops are apt to suffer. These sand types are very easily tilled, and are the earliest soils in the county. They are well suited to the production of early truck crops, peaches, grapes, and light farming.

The Portsmouth sandy loam, Portsmouth fine sandy loam, and Portsmouth loam are fairly easily tilled and very productive soils. Owing to their low, flat surface they must be artificially drained. They are by far the best corn soils in the county and also in eastern North Carolina. Cotton does well on the better-drained areas, and cabbage and onions would prove profitable crops.

The Swamp is at present nonagricultural. Some of it is used for summer pasturage. It is usually forested with cypress and gum.

SOIL SURVEY OF OCONEE COUNTY, SOUTH CAROLINA.

By W. E. McLENDON and W. J. LATIMER.

DESCRIPTION OF THE AREA.

Oconee County, with an area of 417,216 acres, or about 652 square miles, is situated in the northwestern corner of South Carolina, between parallels $34^{\circ} 25'$ and $35^{\circ} 5'$ north latitude and meridians $82^{\circ} 45'$ and $83^{\circ} 25'$ west longitude. Taking east for north the shape of the county is roughly that of the State. It is bounded on the north by North Carolina, on the east by Anderson and Pickens counties, and on the southwest, west, and northwest by the State of Georgia.

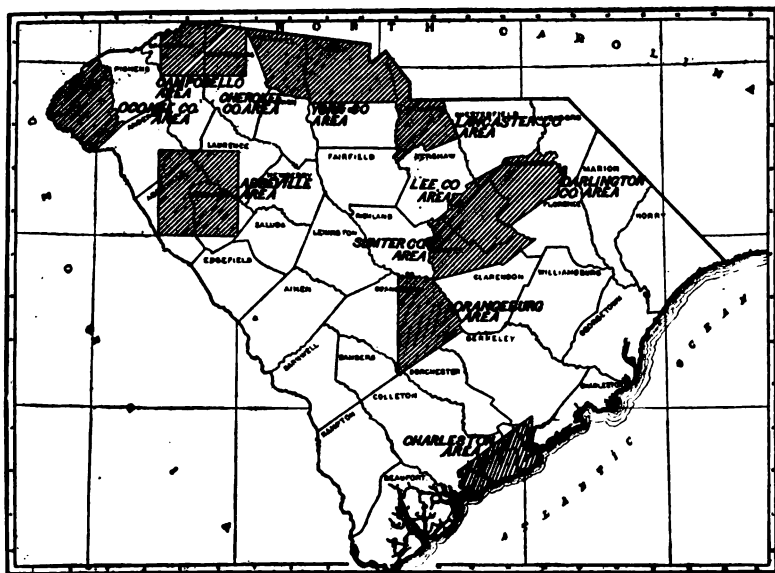


FIG. 8.—Sketch map showing location of the Oconee County area, South Carolina.

The line between the county and Georgia is formed by the Tugaloo and Chattooga rivers and between it and Pickens County for most of the distance by the Toxaway and Keowee rivers. A little less than two-thirds of the county is in the Piedmont Plateau, the remainder being higher and of a mountainous character. In the Piedmont, which is confined to the southern and eastern parts of the county, the characteristic rolling topography of the upland country is well developed, the altitude ranging from 850 to 1,200 feet above sea level. The high altitude and proximity to the mountains have caused the devel-

opment of an intricate system of rapid flowing streams, which have carved out deep, narrow valleys with little or no overflow lands. Where the drainage channels are very deep, as is the case near the mountains along the upper Keowee and Tugaloo rivers, the topography generally is rough and broken. In many other places the streams are bordered by steep slopes, only a few of which, however, are too rough to be successfully farmed. On the northwest the Piedmont gives way rather abruptly to a rough mountainous escarpment with an elevation of 1,500 to 2,000 feet above sea level. In this rim are a number of peaks standing out prominently from the south and east, but they are only slightly higher than the territory immediately beyond. In the northern end of the county the mountains are very rough except for local areas, and rise gradually toward the Chattooga Ridge, which extends along the northwestern border of the county for some 15 miles, and on the north, toward the higher mountains of North Carolina. The Chattooga Ridge has an elevation of 2,000 to 3,100 feet above sea level. Much higher elevations are reached in the adjoining counties of Georgia and North Carolina. In the central western part of the county is a semimountainous plateau of about the same altitude as the broken rim overlooking the Piedmont Plateau on the south and east. Local differences in elevation through the roughest areas range from 600 to 1,000 feet and in the less broken areas from 50 to 500 feet. Streams are very numerous and flow for the most part through deep, rugged valleys, gorges, and canyons. Some of the streams in their rapid descent from the mountains have developed very picturesque rapids, cascades, and falls, the most notable among these being along the Whitewater River and the upper forks of Little River.

The drainage of the county is to the south into the Savannah River through two streams of about equal magnitude, namely, the Seneca and Tugaloo rivers, and their numerous tributaries. The Seneca River drains the eastern and central parts of the county, and the Tugaloo the southern border and the western intermountain areas. The extreme northwestern edge is drained by the Chattooga River, which, with the Tallulah River from the Georgia side, forms the Tugaloo. The plateau section of the mountains is drained by the Chauga River, which flows south into the Tugaloo. Toxaway Creek, also rising well up in the mountains, is a tributary of the Chauga. Ramsey Creek, another of its tributaries, rises between Rich and Poor mountains and swings to the east of the mountainous areas. Among the tributaries of the Tugaloo may be mentioned Brasstown, Longnose, Choestoea, Cleveland, and Beaverdam creeks. The Seneca River is formed by the junction of Keowee and Little rivers, and Keowee in turn by the junction of the Toxaway and Whitewater rivers, which enter the county from North Carolina. Little River

risers in the northern part of the county and flows in a southeasterly direction to within less than a mile and a half of the Keowee River, at which point it turns south, flowing some 6 miles before uniting with it. Cane, Tomassee, Oconee, and Crooked creeks are the principal tributaries of Little River. Coneross Creek rises near the center of the county and flows in a southeasterly direction, leaving the county about a mile south of the point where the Seneca River goes out. Excellent locations for large power plants are found in many places along the larger streams. As yet nothing has been attempted on a large scale, except at Newry, where a cotton mill is being very successfully operated. A number of gristmills are found on the creeks where sufficient power is easily developed.

Prior to 1755, when a treaty was made with the Cherokee Indians, there were very few settlers in the northwestern part of the State, especially in the territory embraced by Oconee County. For several years afterwards settlements were slow and very much hampered by the Indians. During the course of the Revolutionary war the Indians were driven from the section. Immigration then started to this county, and it was not long before all of the better lands were fairly well settled. The mountainous areas are now and have always been very sparsely settled. The settlers came from the lower part of the State, Virginia, and other of the older sections south of Pennsylvania. About the only foreign immigrants were Germans, who settled near the center of the county and were largely responsible for the founding of Walhalla, the county seat. With the possible exception of Pickens County, the percentage of whites over the negroes is larger than in any other county in the State. In the mountains the population is almost entirely white.

The county has an extensive system of public roads which would prove adequate for a much larger population. Most of them are in good condition, although some of the roads crossing valleys have too steep grades to allow heavy hauling without difficulty. Within the last few years some of the worst grades have been done away with, and more improvement is expected in this line as the agricultural development goes forward. Another incentive to better roads is the rural free-delivery service, which now covers all but the remotest sections in the mountains.

The railroad facilities, though not extensive enough, are fairly good. The main line of the Southern Railway crosses the south-central part of the county in a general east and west direction, affording quick and direct service to all points west and north. The Blue Ridge Railway, terminating at Walhalla, is a short line operated as a branch of the Southern. This gives a direct outlet to the South. Better facilities are very much needed in the northern, western, and southern parts of the county.

Walhalla, Seneca, and Westminster, each with a population between 1,000 and 2,000, are the principal towns and trading centers. Newry, Madison, Richland, and West Union are some of the smaller railroad towns. Fair Play is a small place in the southern end of the county, and Salem, a town of about the same size, is 12 miles north of Walhalla. Clemson College is situated in the extreme eastern end of the county. The cotton crop is handled partly by mills at Newry, Seneca, Walhalla, and Westminster, and the remainder is shipped to outside markets. Practically all of the beef cattle that can be had for miles around are consumed at Clemson College. The mountain trade, even from points in Georgia and North Carolina, is conducted at Westminster and Walhalla.

CLIMATE.

Oconee County has a mild, pleasant climate, adapted to a great diversity of farming crops. The condition in the nonmountainous areas are very well represented in the tables below, which were compiled from records of the Weather Bureau stations at Walhalla and Clemson College, both places being in the county. The fact that Walhalla is about 200 feet higher than Clemson College makes the summer months a few degrees cooler at that point. On the other hand, the winter months are slightly warmer at Walhalla on account of the sheltering influence of the nearby mountains in protecting it from the cold north and northwest winds. The summers are long and warm, but they are not attended by hot, oppressive periods, except sometimes during the months of July and August, and even then the nights are cool. The winters are mild and usually attended by a light snowfall. In the mountains there is a greater range of temperature and the nights are quite cool even during the growing season, a condition very unfavorable to the successful growing of cotton. The mountains, as well as the nonmountainous areas extending north from a point 2 miles north of Tamasssee and Salem, may be considered as out of the cotton belt. The pleasant climate and picturesque scenery of the mountains are attracting quite a number of tourists to this section each summer.

Normal monthly and annual temperature and precipitation.

Month.	Walhalla.		Clemson College.		Month.	Walhalla.		Clemson College.	
	Temper- ature.	Precip- itation.	Temper- ature.	Precip- itation.		Temper- ature.	Precip- itation.	Temper- ature.	Precip- itation.
	°F.	Inches.	°F.	Inches.		°F.	Inches.	°F.	Inches.
January	42.1	4.14	41.9	4.63	August	76.7	5.92	80.1	4.92
February	44.8	4.32	41.8	5.45	September ..	70.4	4.78	73.3	3.93
March	50.0	6.78	52.7	4.47	October	59.6	3.40	63.1	3.10
April .....	.....	.....	59.2	3.90	November ..	49.6	3.41	51.2	3.21
May	67.3	2.94	70.3	3.21	December...	44.3	2.98	42.5	3.54
June	75.3	4.92	77.1	5.76	Year .....	.....	.....	61.0	51.88
July	76.5	5.30	79.0	5.21					

Dates of first and last killing frosts.

Year.	Walhalla.		Clemson College.		Year.	Walhalla.		Clemson College.	
	Last in spring.	First in fall.	Last in spring.	First in fall.		Last in spring.	First in fall.	Last in spring.	First in fall.
1899.....	Apr. 10	Nov. 3	Apr. 9	Nov. 4	1903.....	.....	Oct. 24	Apr. 4	Oct. 25
1900.....	Apr. 13	Nov. 9	Apr. 13	Nov. 9	1904.....	Mar. 29	Oct. 24	Apr. 5	Oct. 24
1901.....	Apr. 10	Nov. 6	Mar. 22	Nov. 5	1906.....	Mar. 25	Oct. 11	Mar. 21	Oct. 29
1902.....	Apr. 8	.....	Mar. 20	Nov. 27	Average	Apr. 6	Oct. 28	Mar. 31	Nov. 4

It will be seen from the first table above that the annual precipitation is a little more than 50 inches. This is very well distributed throughout the year, but occasional droughts during the summer months cause an immense amount of damage. On the other hand, prolonged wet spells are just as harmful. As a whole, however, the temperature and moisture conditions are very favorable to plant growth. Not much can be done to prevent the harmful results of excessive rainfall, except to stop erosion and prevent overflows as much as possible, but the effects of droughts can be largely overcome by proper methods of tillage and cultivation and the exercise of care in selecting crops adapted to the different soils. The mountains have quite a local modifying influence upon rainfall during the summer months. Rain will fall along the edge of the mountains, but a mile or so away the crops may suffer from drought, the effect being very much the same as that exercised by swamps or bodies of water in diverting the course of showers. The fall months are the driest of the year, the weather being usually very favorable for gathering the cotton crop.

At Walhalla the average date of the last killing frost in the spring is April 6 and of the first in fall is October 28, while at Clemson College the corresponding dates are March 31 and November 4. The growing season is about seven months long, or about two weeks shorter than in the Coastal Plain region of the State. The shorter season makes it more difficult to grow heavy yields of cotton, as very often the late bolls are frost-bitten before they reach maturity. This is especially true on the clay lands. The erratic occurrence of frosts in the spring makes the peach crop somewhat uncertain, and other fruits are affected to a less extent.

AGRICULTURE.

The early settlers confined their efforts largely to the cultivation of the fertile bottom lands, as at that time the rolling uplands were not considered of much value for farming. This idea was due probably to the fact that many of the settlers came from leveler sections, or because corn, the chief crop, gave much better yields on the bottom

lands without much care and with little deterioration of the soil after years of careless tillage.

Gradually, however, settlements extended all through the uplands, many of the farms including little or no bottoms. The leveler sandy lands were first occupied, then the more rolling tracts, and lastly the mountainous areas, which are still very sparsely settled. Even at the present time the best and most extensive developments are found on the moderately rolling sandy loam types. The individual holdings, as a rule, were rather large, but the land brought under cultivation depended upon the supply of labor at hand.

Being far from markets, the settlers turned their attention to producing corn, oats, wheat, and such other crops as could be consumed at home or easily exchanged. Nearly every farmer raised hogs for pork and lard, and a great many kept at least a few cattle and sometimes small herds of sheep. Much of the spinning and weaving was done at home. Cotton, although grown to a limited extent, did not play an important part in the agriculture of the county until after the civil war. Land being cheap and plentiful, the farmers gave very little attention to keeping the soil in a productive state by means of good tillage or the proper rotation of crops. If a field became very much run down after some years of cultivation, it would be abandoned and new lands cleared to take its place. The farmers were for the most part out of debt, but there was, in general, no great degree of prosperity.

As the necessity for a ready-money crop was strongly felt after the civil war, cotton began to be grown on an increasing scale until it became the most important crop throughout the county where it could be grown successfully. In the mountains, which are out of the cotton belt, corn continued to be the most important crop. Wheat continued to be grown, but with the increase in the acreage of cotton less and less attention was given to other lines of farming. As a result, in the Piedmont section, although it is admirably adapted to stock raising, dairying, and the growing of a great variety of forage crops, practically nothing is being done in these lines. The average farmer does not produce a running supply of corn. Cowpeas, which thrive on any of the soils and afford excellent feed and the cheapest means of improving the soil, are not grown nearly as extensively as they should be, nor do they play an important part in the rotation of crops. The whole system is that of devoting the best energies to producing cotton and subordinating all the other crops. Instead of depending upon cotton almost exclusively as the money crop, and buying the necessities that could be produced more cheaply at home, a more diversified farming will lead to better results and keep the farms in a higher state of productiveness. The necessity for diversification is being more fully realized every year. Some have begun

growing small patches of tomatoes for canning. These command a good price in the local markets. Quantities of sweet potatoes are also canned for the market, going largely to outside points.

The farmers in the mountains, with few exceptions, are operating on a small scale. In addition to corn, some of which is marketed, small patches of cabbage, Irish potatoes, and onions are grown to be sold in the late fall months. These, with some apples and chestnuts, are brought down from the mountains and sold in the towns and country districts for miles around. Some of the owners supplement their incomes by the sale of cross-ties and lumber. Practically all of the best timber has been removed, and what is still standing is held largely by lumber companies. With the cotton growers there has been a decided change for the better within the last ten years, due to better prices paid for cotton. The home surroundings are being improved, and better methods for farming are gradually coming into favor, although there is still room for considerable improvement. The scarcity of labor could be offset in many instances by adopting the better types of farm implements and machinery, which can be bought at quite reasonable prices.

An idea of the extent and relative importance of the different crops can be had from figures given in the Twelfth Census. Of the 333,038 acres in farms only 99,891 acres were reported as improved. There were 35,080 acres in corn, producing 414,150 bushels; 25,612 acres in cotton, producing 10,148 bushels; 5,858 acres in wheat, producing 30,720 bushels; 2,810 acres in oats, producing 15,880 bushels; and 1,165 acres in grasses, producing 1,391 tons of hay. The other crops had less than 1,000 acres each. Among these may be mentioned cowpeas, sorghum, sweet potatoes, Irish potatoes, and miscellaneous vegetables.

The orchard products were valued at \$8,308 and the forest products at \$35,406. In the mountains and the thinly settled sections there is considerable merchantable timber, but this is being removed rapidly, and it is only a question of time when the supply will be practically exhausted. Since 1900 there has been an appreciable increase in the acreage of cotton.

Cotton and corn lands are left bare during the winter months and very little plowing is done in early spring. Where cotton follows cotton, a common practice is not to plow broadcast, but to run center furrows between the old rows, apply the fertilizers, and bed with four furrows. If cotton follows corn or some other crop the land may be broken before the rows are laid off. Most of the after cultivation is done with sweeps and scrapes, which require three trips to the row to complete a cultivation. The crop is laid by in July and early August, while the plants are still growing and fruiting rapidly. Cultivation is done more with the idea of keeping grasses and weeds down

than to conserve the soil moisture for the use of plants. Shallow cultivations in the middles, at least, would prove very beneficial as long as the plants are setting fruit.

Lands intended for cotton should be given a deep breaking during the winter or early spring, and the beds should be made very low, so that the cotton can be cultivated practically on a level. The crop would stand droughts better and less hoeing would be necessary. In late fall rye should be sown broadcast over the cotton fields to act as a cover crop and to afford pasturage during the winter months. More attention should be given to selecting varieties of cotton best adapted to the different soils. Cotton suited to the shallow, rolling soils is rarely well suited to moist, loamy lands, where the habits of growth are entirely different. The crop has a tendency to mature later on clay than on sandy soils. The fall frosts are too early as a rule to encourage late growing, so that an early and rapid fruiting variety would prove best for the clay lands. A large plant growth is an unnecessary drain upon the land, unless the stalks have time to fill out well with bolls.

The methods of planting and cultivating corn are quite variable and do not apply to any particular type of soil, but in all of them there is a general lack of thoroughness which in most cases means a poor crop. On the bottom lands the average yields are not over 30 bushels per acre, whereas if the crop were properly planted and cultivated from 60 to 75 bushels per acre could be obtained. The upland soils used for corn culture ought to yield on an average about 30 bushels per acre, but the general average is less than 15 bushels, although a great many farmers make applications of commercial fertilizers. On the bottom lands the rows are from $3\frac{1}{2}$ to 4 feet apart and the hills from 15 to 24 inches in the drill, one or two stalks being allowed to stand in the hill.

The planting is done on level ground or on low flat beds. On the uplands more space is allowed. The rows are from 4 to 5 feet apart and the hills from 2 to 3 feet. Usually not more than one plant in the hill is allowed to stand. The upland soils being drier and warmer, the furrow method of planting is more generally practiced. This system gives the plants a deeper root development, which is very desirable during dry seasons, and makes it easier to keep down grasses and weeds between the plants without the use of the hoe. Cultivation is done with scooters, light turning plows, sweeps, etc., which require several trips to the row to complete a single cultivation. Much time and labor would be saved by using a cultivator. The practice of "pulling fodder" is followed throughout the county.

Large quantities of commercial fertilizers are used. In 1900 the expenditures for this purpose amounted to \$53,870. With the increase in the acreage of cotton more fertilizers are being used each

year, despite the fact that the price is rising. They are also coming into more general use for corn on the uplands. For cotton the applications range from 150 to 600 pounds per acre, some using as much as 1,000 pounds apparently with good results. It is argued that if twice as much, or even a third more, cotton can be grown with 800 or 1,000 pounds as with 400 pounds per acre, the heavier application is a good investment. It is doubtful if the heavy applications will give satisfactory results unless the soil is prepared deeply so as to allow an extensive root development. There is a general lack of knowledge as to the manurial requirements of the soils, except that they respond in greater or less degree to any fertilizer. As a matter of economy it pays to buy only the best grades, preferably the different ingredients, and mix them at home. Some use complete fertilizers, some just the acid phosphate, others a mixture of cotton-seed meal, acid phosphate, and kainit in varying proportions. Where stable manure is applied some farmers omit the cotton-seed meal. The soils in general give less response to potash than to either nitrogen or phosphorus. In addition to the usual applications of fertilizers at planting time, some give a top dressing of nitrate of soda after the crop has some size. It is not good economy to use the cotton seed as a fertilizer. They should be exchanged for cotton-seed meal, as in this way a good price is obtained for the oil, which is useless as a fertilizer. The meal being fine, it acts more readily than the seed, which require some time to rot.

The practice of a rotation of crops is the exception rather than the rule. In a great many instances cotton follows cotton for a number of years. Again, cotton and corn alternate in an irregular way. With the two-crop system a good plan would be to grow cotton two years and corn one year. At laying-by time cowpeas should be broadcast or sown in rows through the corn. The peavines would add a great deal of humus to the soil and put it in better shape for the next crop. A better plan would be to plant in cotton one or two years, in corn one year, and in oats and peavines the next. By the proper rotation of crops it would be possible to grow good corn without commercial fertilizers, and the quantity used for cotton could be greatly reduced. Every effort should be made to keep the soil well supplied with humus.

A few general soil adaptations are recognized. In so far as possible the corn crop is confined to the bottom lands and the cotton to the uplands. The clay lands are better adapted to cotton than to corn. The tendency with every farmer is to grow the general line of crops, regardless of the kind of soils on his farm. It has been found that the sandy lands grow good peaches, but only a few efforts have been made to extend the industry on account of the erratic spring frosts, which make the crop very uncertain.

On an average the farms in Oconee County contain between 100 and 500 acres, and there are few with more than 1,000 acres. At least a part of each large plantation is rented out in tracts of 25 to 75 acres. According to the Twelfth Census the average size of farms was 102.5 acres, but the tenant holdings were counted as farms in this report. About 33 per cent of the farms are operated by the owners, the remainder being rented.

Land is rented in a number of ways. If the owner furnishes the land and fertilizers he usually gets half of the crop; if only the land, he gets a third or fourth. Another popular plan is to rent a house and so many acres of land for a stipulated amount of lint cotton, ranging as high as 3 bales for a one-horse crop. Cash rentals range from \$2 to \$7 an acre, depending upon the character of the land. A great part of the labor is absorbed in the tenant system, but where hired by the day farm hands get 60 to 75 cents a day, and by the month \$12 to \$16, with board or house and rations.

The better lands through the Piedmont section sell for \$25 to \$50 an acre, although near Walhalla, Westminster, and Seneca as much as \$75 an acre is asked. Less desirable areas can be bought for \$10 to \$20 an acre. The bottom lands are held at higher prices than the uplands on account of their natural productiveness and level surface. The rough mountain lands are valued chiefly for the timber they support, the price ranging from a nominal amount to \$5 an acre, while the cultivable areas sell for \$5 to \$20 an acre. The value of the cotton lands has almost doubled in the last ten years, and no doubt will go higher if cotton continues to bring a good price.

With the growing scarcity of labor the farmers are finding it necessary to confine their efforts to smaller areas than heretofore. The lands that can not be kept up are either rented or abandoned. Better conditions could be brought about by better agricultural methods. More attention should be given to forage crops and pasturage, which do not require a great deal of labor. The section is admirably adapted for cattle, sheep, and hog raising, and these animals command good prices in the market. This line of farming would not only lead to a substantial prosperity among the farmers, but it would afford a cheap and efficient means of keeping the soils in a productive state. More intensive farming would be practicable if a good class of immigrants could be obtained and were allowed to take up lands in small tracts of 25 to 50 acres. The immigrant farmer and his family could do nearly all the work on such an acreage, thus affording a solution of the labor problem.

SOILS.

The soils fall naturally into two general groups, the alluvial bottoms and the residual uplands. The latter group may be further

divided into the soils of the rolling lands of the Piedmont Plateau and those of the rough mountainous areas, both divisions having nearly the same geological formations, but differing widely in topography and climatic conditions. All of the upland soils in the Piedmont section have red subsoils and belong to the Cecil series. Those of the mountains, with one exception, are members of the Porters series. The alluvial lands, which are very limited in extent, have been mapped as the Congaree fine sandy loam.

The residual soils are derived from the weathering of very ancient metamorphic, igneous, and sedimentary rocks, most of which are highly crystalline.* Granites, gneisses, and mica schists are by far the most important. The sedimentary rocks are confined to one formation known as the Brevard schist and occupy a strip from 1 to 2 miles wide across the county, entering North Carolina just west of the Toxaway River. A few small areas are found to the east of this strip, capping Poor Mountain and some of the other near-by peaks. The formation consists of dark-gray to black slates and schists, with occasional lentils of marble and irregular thin layers of sandstone. To the west of the Brevard schist is an extensive area of the Carolina gneiss, which is a highly metamorphic formation consisting for the most part of interbedded fine-grained gneiss and mica schists. Immediately east of the Brevard schist there is found a broad strip of the Henderson granite, this being interstratified in places with the Roan gneiss. The largest area of the Roan gneiss, however, occurs in a long strip along the eastern border of the Henderson granite. The Henderson granite is a light-gray granite rather poor in iron-bearing minerals. The Roan gneiss, on the other hand, is a dark-gray to nearly black heavy rock consisting of hornblende gneiss, hornblende schist, and diorite, interbedded with other rocks of minor importance. The remaining half of the county is occupied by a gray medium-textured gneiss (Whiteside granite), through which are interspersed occasional small patches of the Carolina gneiss, narrow bands of the Roan gneiss, and possibly local areas of massive granite. The acidic or lighter colored rocks weather into the lighter textured soils, which vary from loam to sandy loam in texture, and the darker colored or basic rocks weather into the clay loams and clays.

The Brevard schist and the Carolina gneiss are almost wholly within the mountains. The Henderson granite and the Roan gneiss are partly in the mountains and partly in the Piedmont, while the large area of gneiss in the eastern half of the county is entirely in the Piedmont Plateau. In the Piedmont the gneiss or Whiteside granite gives the Cecil sandy loam and a sandy phase of the Cecil

* The geological names are those used in the Plagah Folio, U. S. Geological Survey.

clay, the Henderson granite gives the Cecil fine sandy loam, and the Roan gneiss gives the typical Cecil clay. In the mountainous and semimountainous areas the Henderson granite gives the Porters fine sandy loam, the Brevard schist gives the Porters clay loam, and local areas of the Porters clay, the Roan gneiss gives the Porters clay, and the Carolina gneiss in the roughest areas gives the Porters loam, and in the semimountainous plateau lands the Pilot loam. Small areas of Porters clay are also derived from the Carolina gneiss.

The alluvial lands are derived from wash from the different formations and they vary somewhat with the adjacent uplands, depending upon the size of the streams.

Nine types of soil were recognized, the name and extent of each being shown in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Cecil sandy loam	176,640	42.5	Porters fine sandy loam	24,128	5.7
Cecil clay	48,448	11.6	Congaree fine sandy loam...	23,360	5.6
Cecil fine sandy loam	87,248	8.9	Porters clay	13,504	3.2
Pilot loam	88,792	8.1	Total	417,216	.....
Porters loam	33,664	8.1			
Porters clay loam	26,482	6.3			

CECIL SANDY LOAM.

The Cecil sandy loam, to a depth of 5 to 8 inches, is a brown medium-textured sandy loam, rather low in organic matter in the cultivated areas. Strewn over the surface and mingled with the soil are varying quantities of angular quartz fragments, but except in very small areas the quantity present is not sufficient seriously to interfere with proper methods of tillage or to render the soil unduly droughty. The subsoil is a strong, red sandy clay, extending to a depth of several feet without much change in color or texture. Lower down the clay grades into soft, weathered material which in an undisturbed condition has much of the original gneissoid structure of the parent rock. Quartz veins ranging from less than an inch to a foot or so in thickness are of frequent occurrence throughout the subsoil. The soil is easily tilled and responds readily to good methods of treatment.

In nearly every field are found local clay areas, or "gall spots" produced by erosion. The same agency is also responsible for a shallow phase of the type occurring on most of the farms to some extent.

A phase of the type which is not considered very desirable is found on some of the high knolls and steeper hillsides, where the parent rock is not weathered to any great depth below the surface. Ledges and loose fragments of a porous, rotten stone occur in the subsoil and fragments of the same material with the usual quantity of quartz are

found strewn over the surface. Some areas are too stony to be farmed successfully to cultivated crops, while a great many others can be handled with a fair degree of ease. The soil is a reddish-brown rather heavy sandy loam 4 or 5 inches deep and the subsoil is a deep-red sandy clay. The rolling topography causes most of the rainfall to run off at the surface, and what is absorbed rapidly disappears in the porous rotten stone below. As a consequence the soil is too droughty to produce good crops unless the rainfall is well distributed. Areas similar to the above also occur in narrow, ill-defined strips extending generally in a northeast-southwest direction. This phase of the type is referred to as "Rotten-stone land." The sandiest phase is found on some of the crests of the gentler drainage divides and occasionally in small areas along the lower slopes. The soil to a depth of 8 to 12 inches is a brownish-gray sandy loam, underlain by a red sandy clay or by 6 to 12 inches of a yellowish-brown clay below which is the typical red clay. This phase of the type is sometimes called gray sandy land in contradistinction to the areas with a shallow brown soil and a deep red subsoil.

A phase of minor importance is found on some of the low-lying gently rolling areas or table-lands near the larger stream courses. These areas represent old terraces left by the streams in the process of deepening their valleys. Practically all of the fine alluvial deposits have long been removed, but many of the waterworn gravels and boulders have been left scattered over the surface. The soil is a shallow, brown sandy loam, overlying a red sandy clay. This phase is considered better land than the high, rolling areas back from the streams.

In the southern and eastern parts of the county the Cecil sandy loam covers large areas almost to the exclusion of any other upland type. The topography consists of long drainage divides with numerous laterals. This gives a general rolling topography, with occasional quite rolling broken areas along some of the streams. The streams are from 25 to 200 feet lower than the crests of the adjacent ridges. The areas between Little and Keowee rivers in places are quite rolling, and some parts of them are broken and undesirable. This is also true of some parts of the area west of Chauga River, and in local areas along the Tugaloo River farther south. Here the streams in places are bordered on one side or the other by steep slopes, often rising into knolls considerably higher than the surrounding country. The stony phase of the type is most in evidence through the rolling and broken areas. The principal body of the sandy phase described above is found around Fair Play. Another area extends along the Westminster road just south of Walhalla.

The Cecil sandy loam is a residual soil derived from a gray gneiss or gneissoid granite consisting of orthoclase and plagioclase feldspars,

quartz, and muscovite and biotite mica, named in the order of their importance. Local areas, no doubt, are derived from a massive granite of about the same color and composition. Small schistose areas may have been formed from the Carolina gneiss. Here and there are found occasional narrow bands of the Roan gneiss, which generally weathers into the Cecil clay. The Cecil sandy loam typically is derived from the more massive rocks, while the schists usually weather into a slightly heavier soil. Small areas of the "Rotten-stone land" are merely the result of erosion. Others follow a certain phase of the gneiss, which allows the feldspar and mica to weather and leaves the quartz grains cemented together with oxides of iron.

The timber growth consists mainly of shortleaf pine, Spanish, red, white, and post oaks, and an undergrowth of dogwood. About all of the merchantable timber has been removed.

The Cecil sandy loam is the most desirable soil in the area for general farming purposes and is well adapted to a number of crops not now grown. It is quite probable that a good grade of tobacco could be produced, as the same soil is used extensively for this purpose in North Carolina and Virginia. In Georgia, where the climatic conditions are favorable, it is highly prized as a peach soil. A few orchards have been started in Oconee County, but they have not been given the proper care. The uncertainty of profitable crops on account of spring frosts no doubt will prevent an extensive development of the industry. Stock raising and dairy farming are two other promising industries that are not followed on a commercial scale. Cotton is the first crop in acreage and importance and corn is the second. So far as practicable the corn crop is confined to the bottom lands and the cotton to the uplands. Oats are grown at least to a limited extent by a majority of the farmers, and many plant wheat as one of their important crops. The oat crop is intended almost exclusively for home use. Peanuts are being grown in a limited way for the market. Among other crops for home consumption may be mentioned sorghum for sirup, and forage, sweet potatoes, and cowpeas, besides a number of miscellaneous vegetables. A number of farmers plant small patches of tomatoes for canning purposes. The canning of sweet potatoes is also receiving considerable attention. Ordinarily these two industries prove very profitable and can be handled with little or no outside help. Under the prevailing system of management the average yield of cotton is between one-fourth and one-half bale; corn yields from 10 to 25 bushels, and wheat from 6 to 10 bushels per acre. Some of the best farmers find it just as easy to make a bale of cotton per acre and correspondingly larger yields of corn. Commercial fertilizers are freely used, especially with the cotton crop, and very often without the application of any rough manures.

The soil needs deeper and more thorough tillage than is now generally practiced, and a system of rotation should be followed that will keep it well supplied with humus. The present system of planting continuously to cotton, or any other crop for that matter, and applying commercial fertilizers alone will never be attended with the best results. To insure profitable returns a greater diversity of crops should be grown, thus not only increasing the resources of the farm, but affording an easy means of permanently improving the soil. Areas that can not be properly protected from erosion should be devoted to pasturage, sowing Bermuda grass or some other grass that will make a tough sod and at the same time provide good grazing. The South Carolina experiment station farm at Clemson College consists very largely of this type of soil.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Cecil sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18229, 18231.....	Soil	6.9	18.8	12.8	28.7	6.7	19.6	6.9
18230, 18232.....	Subsoil.....	3.3	10.6	6.9	14.1	4.2	16.1	45.1

CECIL FINE SANDY LOAM.

The soil of the Cecil fine sandy loam, to a depth of 3 to 5 inches, is a light-gray fine sandy loam carrying a small quantity of angular quartz fragments and only a small percentage of organic matter. Material of the same texture, but of a light-yellowish or yellowish-brown color, extends to a depth of 6 to 12 inches, where it grades into a light fine sandy clay, mostly of red color. Some of the sandiest areas have a yellowish-brown subsoil to a depth of 15 to 18 inches, and from this fact they have been called "Mulatto lands." The clay becomes lighter colored and less coherent with depth, and passes gradually into soft weathered rock. The light clay subsoil and the incoherent underlying material makes the type very susceptible to deep and destructive erosion. Even where the clay is reddest it does not have the strong red color characteristic of the subsoil of the Cecil sandy loam. It also differs from the latter in that it does not contain a noticeable quantity of mica. The type as a whole has a high quartz content and is naturally less productive than the Cecil sandy loam, and is not so responsive to improvement.

The Cecil fine sandy loam occurs in strips and irregular areas coincident with nonmountainous bodies of the Henderson granite. The largest strip extends almost across the county in a general northeast-southwest direction, passing about 2 miles to the west of Walhalla.

The surface features in general are rolling and some areas where the drainage is excessive are rather too badly broken to be farmed successfully. Some areas near the mountains have a somewhat hummocky appearance in addition to the general rolling topography. The natural drainage is perfect.

The Henderson granite, from which this type is derived, is a light-gray or light bluish-gray siliceous granite. In most places it is fine-grained and has a slight gneissoid banding. The small percentage of mica present does not show up to any extent in the weathered material. Ledges of the hard rock are to be seen on many of the steeper slopes.

The native timber growth consists largely of oak and pine, as on the Cecil sandy loam, but the growth, especially of oak, is more scrubby.

Not more than 10 per cent of the soil is under cultivation. Around Salem, along Fall Creek and the upper tributaries of Little River, and to the west of Walhalla are some of the best farms on the type. Cotton is the chief crop, the average yield being about one-third of a bale per acre. Corn yields are very light, unless the land is well fertilized. A few other crops are grown on a limited scale for home use. Very few of the farmers have orchards of any consequence. Of the small grains, rye would prove profitable, although very little is grown.

By using rough manures and commercial fertilizers liberally, cotton can be made to produce a bale or more to the acre. Instead of planting continuously to cotton, however, a system of rotation should be practiced, namely, planting to cotton one or two years, then to corn, following this with rye; after the rye is cut in early summer broadcasting to cowpeas, which will give a good crop of hay. Cowpeas should be planted between the rows of corn and a row of peas in every other cotton middle. The pea stubble and vines improve the texture of the soil and increase its productiveness. The soil needs more organic matter or humus. All systems of cropping should, therefore, be planned with a view of keeping the soil well supplied with humus, otherwise farming on this type will not prove very remunerative.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Cecil fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
19235.....	Soil	0.9	6.3	8.8	41.2	12.9	24.2	5.6
18236.....	Subsoil.....	.6	6.0	6.9	25.2	15.4	14.6	31.5

CECIL CLAY.

The soil of the Cecil clay to a depth of 3 to 6 inches is a reddish-brown clay loam or heavy fine loam. A small quantity of quartz fragments are usually found strewn over the surface of the type, and in a great many places partially weathered fragments of the parent rock. The subsoil to a depth of 3 to 10 feet is a deep-red heavy clay. The upper 2 feet of the subsoil are comparatively free from stone fragments, but below this depth stone is more in evidence, occurring mostly in ledges. The stoniest areas, being hard to handle, are not in general use. When viewed across the field the soil appears quite red.

A sandy phase of the type occurs through the Cecil sandy loam belt. Some areas here are the direct result of erosion, while others represent the original soil as left after the process of weathering. Some of the "Rotten-stone lands" referred to under the Cecil sandy loam, where the soil was almost a clay, were mapped with this phase of the Cecil clay. The soil may be described as a reddish-brown heavy sandy loam, 2 to 4 inches deep, overlying a deep-red clay considerably more sandy than the typical subsoil. The comparatively level areas are not very stony as a rule and they are considered first-class land. Areas with a great deal of stone at the surface and through the subsoil can be made to produce good crops during wet seasons, but all crops suffer during droughts and sometimes the yields are very poor.

"Red land" and "Chocolate land," or even "Black land," are descriptive terms commonly applied to this soil.

The typical areas occur to the west of the Cecil sandy loam, principally in strips alternating with the Cecil fine sandy loam. The largest strip extends from about 3 miles southwest of Walhalla beyond the county line north of Fall Creek Church. Smaller areas occur in the Tomassee and Longnose Creek neighborhood. The principal areas of the sandy phase are found north of Richland and north and east of Walhalla. The small bodies near Madison are semimountainous and undesirable, except for pasture lands. The surface of both phases ranges from moderately undulating to quite rolling, with local badly broken areas along some of the streams. Numerous areas are being ruined by erosion.

The sandy phase of the type is derived largely from gneiss. The narrow strips with a heavier soil are no doubt derived from dikes of diabase. A great many areas of the sandy phase occur all through the Cecil sandy loam, and nearly every farmer has his clay spots or red lands, which in many places are deeply eroded. The typical areas are derived from the Roan gneiss, which is a dark-colored rock consisting very largely of hornblende gneiss, hornblende schist, and diorite.

The principal tree growth consists of shortleaf pine and a variety of oaks, the latter being more plentiful than on the sandy types.

The best areas of the sandy phase are farmed to the same extent as the Cecil sandy loam, and in very favorable seasons the yields are somewhat heavier than upon that type. Taken as a whole, the Cecil sandy loam, however, is considered the safer soil, because crops are not so much affected by droughts on it as on the Cecil clay. The reason for this, however, is due more to cultural methods than to any characteristic of the soil itself. If the clay is plowed deeply so as to form a deep seed bed, even though it does not contain much humus, it will tide crops over long droughts without much injury. The stony areas or "Rotten-stone lands" are so influenced by droughts that the crop yields are very variable. The heavy phase is less generally farmed than the sandy phase. It has been avoided in preference for the sandy lands on account of its being hard to handle satisfactorily with the implements in general use. With the introduction of heavier and better types of plows the desirability of the clay lands is beginning to be more generally recognized.

The system of farming on this type is essentially the same as that practiced on the Cecil sandy loam, corn and cotton being the only crops grown to any great extent. It is recognized as a better soil for cotton than for corn. The average yield of cotton is less than one-half bale and of corn 10 to 25 bushels per acre. Where the soil is well prepared and properly fertilized it yields a bale or more of cotton and from 25 to 40 bushels of corn. The stony and eroded areas that are not now used should be seeded to grass and clover. Many of the hillsides now considered worthless could be converted into good grazing lands by sowing Bermuda grass. Wheat could be grown on the best areas, especially if a proper rotation of crops were practiced.

Being so near the northern limit of the cotton belt the farmers should plant only early maturing varieties of cotton on the Cecil clay. The crops normally mature considerably later on this soil than on the sandy lands.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Cecil clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18237, 18239.....	Soil	1.3	3.9	3.2	15.7	32.8	24.6	18.4
18238, 18240.....	Subsoil.....	.4	2.1	1.8	7.8	19.1	30.5	37.6

CONGAREE FINE SANDY LOAM.

The Congaree fine sandy loam is a brown mellow fine sandy loam or loam with a depth of 3 feet or more. It is found along swift-flowing streams, and varies considerably in texture. Some areas tend to become sandier with depth, while in others the reverse is true. Along some of the streams subject to frequent overflow the soil to a considerable depth is chiefly a slightly coherent brownish-gray sand. Local modifications have resulted from colluvial wash from the adjacent slopes. Broader differences occur as a result of wash from the different upland soils. Throughout the Cecil fine sandy loam areas the bottom lands are generally sandier than elsewhere and carry very little mica, while throughout the Cecil sandy loam they are quite micaceous. Wherever the soil of the uplands is mainly a red clay, the bottom lands, too, are rather heavy and have a reddish-brown color. Such differences are not so noticeable along the large streams.

A local difference in the river bottoms worth mentioning is found in the form of second terraces above overflow. The soil is a brown fine sandy loam or loam from 8 to 12 inches deep. This rests upon a brown to yellowish-brown clay loam or clay.

The largest areas mapped are along the Whitewater, Keowee, Seneca, and Tugaloo rivers. These bottoms are naturally well enough drained to produce good crops, but they are subject to occasional overflow during very wet weather. In the small bottoms overflows are more frequent and are often destructive. On account of obstructions in the drainage channels the bottoms of Beaverdam, Little Beaverdam, and a few other creeks are so waterlogged that they can not be used for anything except pasturage.

The Congaree fine sandy loam is extensively farmed to corn, and to a less extent to a few other crops. Corn yields from 25 to 70 bushels per acre, depending upon the seasons and the methods of tillage and cultivation. Sorghum and grasses give heavy crops. Cotton does not do well on the overflow strips, but the small second terraces referred to above are good cotton lands, yielding as much as a bale to the acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Congaree fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18243.....	Soil	0.1	0.8	1.5	22.1	23.8	40.2	10.8
18244.....	Subsoil.....	.0	2.2	3.1	44.8	16.5	27.5	5.6

PORTERS FINE SANDY LOAM.

The Porters fine sandy loam, to a depth of 6 to 12 inches, is a gray or pale-yellowish fine sandy loam. In local sheltered areas the soil is deep and dark-colored, while on the steep slopes rock outcrops extensively and the soil gives way at very shallow depth to partially weathered rock. Areas less broken have a yellowish-brown heavy fine sandy loam or light fine sandy clay subsoil which extends to a depth of $2\frac{1}{2}$ to 5 feet and grades into the parent rock, which is in various stages of weathering. Where the normal quantity of sunshine is obtained the soil does not retain much organic matter, and its producing capacity is low.

The type occurs for the most part in two large areas, one of which extends from about 5 miles northwest of Walhalla in a south-westerly direction to the Tugaloo River. The other is found in the northern end of the county. These areas are mountainous except locally. One of the leveler areas is found in the upper extension of the strip to the west of Walhalla. Farther south along the Chauga River and between the Chauga and Tugaloo are some very broken areas. Here and there the streams are bordered on one side by cliffs and precipitous bluffs of almost bare rock. The local differences in elevation are from 100 to 500 or more feet. The peaks and ridges have an elevation of 1,500 to 2,700 feet above sea level.

The Porters fine sandy loam is of the same origin as the Cecil sandy loam, that is, derived from the Henderson granite, which is a gray granite consisting of quartz, feldspar (both orthoclase and plagioclase), and a small percentage of small mica. The small percentage of quartz fragments in the soil and subsoil was left in the process of weathering from veins of quartz occurring through the granite. The scarcity of iron-bearing minerals in the parent rock is responsible for the light color of the weathered material, a characteristic of this and the Cecil fine sandy loam types.

The Porters fine sandy loam is fairly well forested with oak and shortleaf pine. Blackjack oaks are more in evidence and the timber is more scrubby than on the other mountain soils. In the hollows and along some of the shaded slopes which are kept constantly moist, hemlock and a dense undergrowth of mountain laurel and rhododendrons flourish, as well as a scattering of tulip, maple, and other deciduous trees. A few chestnut trees are found on the high ridges in the northern end of the county.

Being mountainous and naturally unproductive for the general crops of the area, practically none of the type is farmed, and it is valued chiefly for the timber it supports. The present valuation ranges from a nominal amount to as much as \$10 an acre. Within the last few years large tracts have been bought by lumber and timber companies.

The efforts to farm this soil have been very limited and primitive. Corn, the chief crop, gives very light yields. The seasons are so modified by the altitude and the proximity to high mountains that cotton can not be successfully produced even if properly fertilized. Small patches of cabbage and Irish potatoes are grown to be sold in the near-by towns and cities. These and sweet potatoes, which are planted to a less extent, do well if given the proper care. Nothing has been done in the way of growing fruits, but it is quite probable that good peaches could be grown in places least subject to late frosts. The type should remain timbered and be included in a National Forest Reserve.

The following tables give the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Porters fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18251.....	Soil	1.0	6.6	6.1	31.6	27.4	18.7	8.1
18252.....	Subsoil.....	1.5	6.7	6.5	27.9	23.5	12.3	22.1

PILOT LOAM.

The Pilot loam is a brown fine sandy loam to loam soil from 4 to 6 inches deep, grading through a few inches of red clay loam into a red friable clay which extends to a depth of 3 to 5 feet, except where ledges of partially weathered gneiss and schist come nearer the surface. The soil and subsoil contain fragments of mica and quartz, and local areas may have pieces of resistant parent rock strewn over the surface. In cultivated areas the soil, if not subject to excessive erosion, becomes a brownish-gray fine sandy loam, but in the timbered areas it is generally a brown loam. In some of the smaller bodies the soil is reddish-brown in color on account of the very shallow depth to clay. The stoniest areas are confined largely to the high knolls, ridges, and the steeper slopes. The soil is easily handled and responds readily to good treatment.

The type is confined to one large area along the western edge of the county. This area, with parts of the Porters clay loam, occupies part of an intermountain plateau intermediate in elevation between the Piedmont Plateau and the mountains proper. On the east and south it gives way to a slightly higher, broken mountainous rim overlooking the Piedmont and on the north and west to high, broken mountains. The general elevation is from 1,500 to 1,600 feet above sea level. The surface features range from moderately rolling to quite rolling, with stretches here and there too broken to be used for farming. Near the heads of the small streams the topography is

much the same as in the Piedmont Plateau, but as they approach their junction points with the larger streams their valleys become deep and rugged. So far as practicable the broken areas along the river, which represent a true mountainous condition, were mapped as the Porters loam.

The Pilot loam is a residual soil derived from fine-grained gneisses and mica schists of the Carolina gneiss formation. It is more extensively farmed than any other of the mountain types, but a large proportion of it is still forested, oak and shortleaf pine being the principal growth. There are a number of farms in the Longcreek and Whetstone neighborhoods, as well as around Battlecreek post-office and along the upper forks of the Chauga River. The tendency is to farm the moderately rolling areas where narrow strips of bottom lands generally are found along the small streams. The methods practiced lack the thoroughness necessary to obtain the best returns from the soil. Corn, the chief crop, yields from 10 to 25 bushels per acre. The seasons are too short for the successful growing of cotton. Small patches of cabbage and Irish potatoes are produced by some for market. Sorghum and sweet potatoes are planted to a limited extent, principally for home use. Practically no attention is given to any of the forage crops, of which cowpeas, clover, and grass would all do well.

The best opportunity is cattle raising. Apple trees thrive and produce a good quality of fruit, but the frequency of short crops on account of frost will prevent any extensive development of this industry.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of the Pilot loam:

Mechanical analyses of Pilot loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18245.....	Soil	3.6	7.5	8.5	34.6	9.4	19.6	18.0
18246.....	Subsoil.....	2.7	6.7	8.9	30.5	8.9	17.2	25.1

PORTERS LOAM.

The rough, mountainous topography of the Porters loam causes considerable variation in the depth and color of the soil material and in the stone content of the surface. In areas not very broken the soil is a brown or yellowish-brown loam ranging from 6 to 10 inches in depth. Quartz gravel in limited quantities is strewn over the surface, and loose fragments of the parent rock are found here and there. On some of the higher peaks and steep slopes local areas are little else than rock outcrops. Others are quite stony, but they have accumu-

lated enough weathered material to support a heavy growth of timber. The upper few inches of the soil are well supplied with humus, and the surface is covered with a good coating of leaf mold, except where forest fires have been prevalent. The dense growth thriving in shaded depressions has helped to build up a deep loamy soil of high organic-matter content. The subsoil of the type in general is a yellowish-brown to light-red heavy loam or friable clay, usually not exceeding 2 to 4 feet in depth before giving way to bed rock in a partially weathered state.

A lighter phase of the soil consists of a brownish-gray sandy loam to loam from 6 to 8 inches deep. The subsoil is about the same in color and depth as is typical, but it is somewhat sandier in texture. The high broken areas are very stony.

The Porters loam occurs in the western and northern parts of the county, mainly in one large area extending from near Whetstone to the North Carolina line. This area outlines in a general way the rough mountains of the Chattooga Ridge. Small isolated areas are comparatively level, but the bulk of the type consists of high peaks and numerous narrow hog-back drainage divides, many of which slope rapidly toward the principal water courses. The drainage is through gorges and narrow rugged valleys. Over very limited areas there are differences in elevation of 100 to 1,000 feet. The general elevation of the peaks and ridges is from 2,000 to 3,000 feet above sea level. The light phase of the type is confined to a few square miles in the extreme northern end of the county.

This soil is residual in origin, being derived from gneisses, mica schists, and granites, with modifications from the rocks of minor importance. The typical areas are from the Carolina gneiss formation, which consists mainly of fine-grained gneisses and mica schists, interbedded in layers from a few inches to 50 feet or more in thickness. On the peaks and high ridges the massive varieties of rock fragments predominate, some being coarse grained and porphyritic and others fine grained. The light phase of the type is from a gneiss or gneissoid granite (Whiteside granite), which in the Piedmont Plateau weathers extensively into the Cecil sandy loam. Although a large part of the type is of the same origin as the Pilot loam, the two types differ very materially in topography and in the color and depth of the weathered material. On the Porters loam cultivable land is the exception rather than the rule, while on the Pilot loam a large percentage of the soil can be successfully farmed. The timber growth consists very largely of deciduous trees, especially on the high peaks, oak and chestnut predominating. In the gorges there is a growth of hemlock, tulip, maple, and a thick undergrowth of mountain laurel, rhododendron, etc.

The limited acreage under cultivation is devoted to corn and a few other minor crops. A few cattle and hogs range over the mountain pastures. The yield of corn usually does not exceed 10 to 15 bushels per acre, except in the small depressions, where the soil is deep and loamy. On the better lands grasses and clover do well. By using the best lands for corn and forage and the thinner rolling lands for grazing purposes large tracts of this type could be very profitably used as pasturage for cattle. Some of the sheltered areas of this type could be used very profitably for apple orchards. The roughest areas should remain in forest.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Porters loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18241.....	Soil	1.6	7.7	7.7	22.7	11.7	27.3	21.1
18242.....	Subsoil.....	2.3	8.1	7.7	22.3	9.5	25.2	25.2

PORTERS CLAY LOAM.

The surface soil of the Porters clay loam, to a depth of 3 to 5 inches, varies from a brown silt loam to a reddish-brown clay loam, depending upon the topography. In rolling areas that have not been subjected to severe erosion the soil, though shallow, is a good silt loam, practically free from stone, with the exception of some angular quartz fragments. In the broken areas and locally where the surface is only moderately rolling the soil is a reddish-brown loam to clay loam, carrying partially weathered fragments of stone, besides the usual quantity of quartz. Where the topography is very broken, as is the case along some of the streams, rock outcrops in frequent ledges and large fragments are found scattered over the surface. The soil does not contain much organic matter, except in the shady depressions. It is about as easily tilled as the Pilot loam, which is a grade lighter in texture, but is naturally less productive.

This soil occurs in a strip from 1 to 2 miles wide, extending across the county in a southwesterly direction from the extreme northern end. The greater proportion of the type is rough and mountainous, but in the neighborhood of Tomassee Creek there is an area of 3 or 4 square miles where the land is rolling. Northwest of Walhalla, along the roads radiating to the west and north, are similar undulating areas at a higher altitude. All of the type is naturally well drained.

The Porters clay loam is derived from the Brevard schist, which is a dark-gray to nearly black mica slate and schist with thin layers

of sandstone here and there, and occasional lentils of marble. Very little of the marble is seen at the surface, consequently it has practically no influence on the soil, but the sandstone layers outcrop in places, especially in the broken areas. The rock in places has a colloidal structure and is quite hard. In other places it appears to be softer and more schistose. Scattered throughout the weathered material are usually found small fragments of a soft talclike material, which probably is mica in a hydrated state. The timber growth is about the same as on the other mountain types, oak and pine being the most plentiful.

Farming operations are confined to small areas where the surface is not very broken. Corn, the chief crop, yields from 10 to 25 bushels per acre. Sorghum and a few other crops are grown in a limited way for home use. All but the very broken areas could be used to the best advantage for summer grazing, as grasses and clovers do well. The best areas should be devoted to corn, cowpeas, sorghum, and other forage crops, which could be fed to advantage during the winter months, or sold for a good price. The worst broken lands should remain forested.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Porters clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18247.....	Soil	0.4	2.2	1.4	13.9	44.6	22.8	15.2
18248.....	Subsoil.....	.5	1.6	.8	11.5	32.1	22.8	30.1

PORTERS CLAY.

The soil of the Porters clay, from 3 to 6 inches in depth, consists of a reddish-brown clay loam to a red clay, having a very similar appearance and texture to the Cecil clay. Quartz and other stone fragments are found upon the surface in varying quantities, and small broken areas are little else than rock outcrop. Where the weathered material has considerable depth, as is the case in all but the stoniest areas, the subsoil, to a depth of 3 or more feet, is a rather heavy clay of deep-red color.

This is the least extensive of the mountain soils, being confined very largely to a broken strip along the outer escarpment of the mountains west of Walhalla. Smaller areas with a similar topography occur farther west.

The Porters clay in its typical development is derived from the Roan gneiss, which is a dark-colored rock consisting principally of

hornblende gneiss and hornblende schist. On Poor Mountain and some of the other near-by peaks are remnants of the Brevard schist formation, which gives rise to a lighter textured and stonier phase of the type. The dark schists and slates characteristic of this formation are almost entirely removed, leaving the layers of resistant sandstone and lentils of marble which show up conspicuously in Poor Mountain. The areas near Longcreek and Whetstone post-offices are derived from certain phases of the Carolina gneiss, being to a certain extent the result of erosion.

Only a few small areas are under cultivation, and these are farmed in the same manner and to the same crops as the other mountain soils. The small rolling areas can be made to produce good crops of corn, grasses, and forage crops. The soil is suitable for the production of good apples, but the elevation is not sufficient to protect the trees from spring frosts. Practically all of the type should remain in forest.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Porters clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18249.....	Soil	1.1	4.2	3.3	14.4	24.2	21.1	31.6
18250.....	Subsoil.....	1.3	3.5	2.3	11.7	20.9	18.3	41.2

SUMMARY.

Oconee County has an area of about 652 square miles and is situated in the northwestern corner of South Carolina. About two-thirds of the county is in the Piedmont Plateau, which is characterized by a general rolling topography, the remainder being of a semi-mountainous and rough mountainous character. The general elevation in the Piedmont section ranges from 850 to 1,200 feet and in the mountains from 1,500 to 3,100 feet above sea level. Excellent locations for large power plants are found along the larger streams.

The better sections of the Piedmont are fairly well settled with a mixed population of whites and blacks, the proportion of negroes being less than in any of the counties farther away from the mountains. The rougher undesirable sections, including the mountains, are very sparsely settled. Here the population is almost entirely white.

The county has an extensive system of roads and a very good rural free-delivery service reaching all but the remotest sections of the mountains. The railroad facilities, though not extensive enough, are

fairly good. Walhalla, Seneca, and Westminster are the chief towns and trading centers. A part of the cotton crop is consumed by local mills at Newry, Seneca, Walhalla, and Westminster.

The climate is mild, pleasant, and adapted to a great diversity of farm crops. The growing season is about seven months, or some two weeks shorter than in the Coastal Plain section of the State. Cotton can be grown successfully all through the Piedmont section, except close to the mountains, where the nights are too cool for its successful growth. The occurrence of erratic frosts in the spring makes the peach crop uncertain, also affecting other fruits to a less degree. Some of the mountain soils are well adapted to the culture of apples, but the altitude is not great enough to afford the proper protection from frosts.

The early settlers grew corn, oats, wheat, and such other crops as could be consumed at home or easily exchanged for the necessities they did not have. The plan was to raise everything for home use and buy as little as possible. Conditions were changed by the civil war. The need of money led to the increased production of cotton, which became the most important crop. Cotton and corn were practically the only crops grown to any great extent.

No system of rotation is practiced at the present time, but commercial fertilizers are extensively used. The necessity for improved methods and a better system of cropping is beginning to be felt.

The general run of the farms contains from 100 to 500 acres. The tenant farms generally range from 25 to 60 acres. About 33 per cent of the farms are operated by the owners, and the remainder are rented to white and black tenants.

Land can be obtained quite reasonably, but the price is gradually rising. The better Piedmont lands can be bought for \$25 to \$75 an acre, the poorer Piedmont lands from \$5 to \$20, and the mountain lands from a nominal amount to \$20 an acre.

Day laborers get from 60 to 75 cents a day, and regular help from \$12 to \$16 a month, with board or rations and a house.

The soils fall naturally into two general groups, the alluvial bottoms, which are very limited in extent, and the residual uplands. The upland soils are derived from ancient metamorphic, igneous, and sedimentary rocks mostly of a highly crystalline nature. All but one of the mountain soils were mapped as members of the Porters series, and those of the Piedmont as members of the Cecil series. The bottom lands were classed as Congaree fine sandy loam. Nine types of soil were recognized.

The Cecil sandy loam is the most extensive and best developed type in the county. It is well adapted to all of the crops of the section, as well as several others that are not now grown. Stock raising and

dairying are two industries that should be developed. The rougher areas should be sodded to grasses and pastured.

The Cecil fine sandy loam is naturally a less productive soil than the Cecil sandy loam, and only a small percentage is under cultivation. Cotton and corn are the chief crops, both giving very light yields unless properly fertilized. More cowpeas should be grown. Rye would prove a profitable crop.

The Cecil clay occurs in two phases. The sandy phase, which is associated with the Cecil sandy loam, is more generally farmed than the typical areas. Cotton and corn are the principal crops. The type is best adapted to cotton, clovers, and grasses. The best areas would produce good wheat.

The Congaree fine sandy loam is a productive soil and nearly all of it is under cultivation. It is best adapted to corn and forage crops. Cotton does not do very well on account of overflows and the tendency to go to weed.

The Porters fine sandy loam is a mountainous type of the same origin as the Cecil fine sandy loam. Very little of it is under cultivation. Corn is the chief crop, the yields being very light. Good vegetables can be grown on the leveler areas. The bulk of the type should remain forested.

The Pilot loam is the best of the mountain soils. Corn is the chief crop. Small patches of Irish potatoes and cabbage are grown for fall marketing. The best opportunity on this soil is raising cattle and sheep.

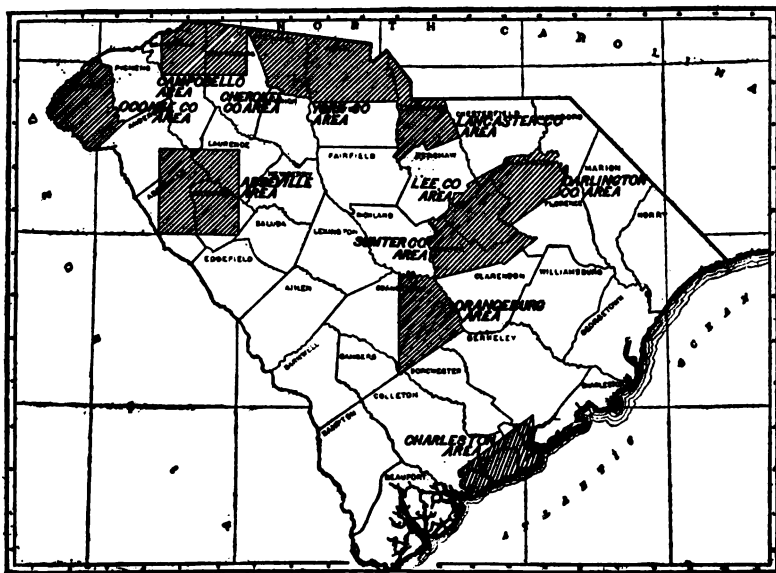
The Porters loam is a rough, mountainous type, very little of which is fit to be cultivated. Some of the best areas could be developed into good pasture lands. Practically all of the type should remain forested.

The Porters clay loam is a semimountainous and rough, mountainous type. Only small areas are farmed, corn being the chief crop. The best areas should be devoted to corn, sorghum, and other forage crops. The less desirable areas could best be devoted to grazing. The rough broken areas should remain forested.

The Porters clay is very broken. Only a few small areas are under cultivation. Practically all of the type should remain in forest. The less broken areas would make good grazing land if sown in Bermuda grass.

By FRANK BENNETT, G. W. TAILBY, Jr., JAMES L. BURGESS, GROVE
B. JONES, W. J. LATIMER, and H. L. WESTOVER.

Sumter County lies in the central-eastern part of South Carolina and comprises an area of 375,424 acres or about 587 square miles. It is bounded on the north by Kershaw and Lee counties, on the east by Florence and Lee counties, on the south by Clarendon and Florence counties, and on the west by Richland County. The surface features



vary from those of a rough and hilly section that has been badly dissected and eroded by stream action to those characteristic of the level and swampy parts of the Coastal Plain. The western and northern parts of the county are the most rolling. Following the Wateree River at an average distance of 3 or 4 miles is a range of hills varying from 1 to 3 miles in width, locally known as the High Hills of the Santee. The line of separation between these hills and the more

level country is very distinct. This chain of hills follows the river up to Stateburg, where it leaves the river and turn to the northeast across the county. North of Stateburg a broad, level or gently rolling area borders the river swamp. Going south from these hills the topography gradually becomes less broken, until the surface finally becomes level and poorly drained. Here the county is cut by small streams bordered by ridges which are fitted for cultivation. The only definite elevations available are those along the railroads. The town of Sumter is 169 feet above sea level, and there is a gradual rise going toward the west until Wedgefield, which has an altitude of 253 feet, is reached. The lowest elevation is in Wateree Swamp, which is 108 feet above tide. Along the hills in the vicinity of Stateburg the elevation will probably reach 400 feet. The chain of hills passing through Wedgefield and Stateburg is drained on the west principally by the Wateree River or smaller streams emptying into this river. The drainage on the eastern side of these hills and in the central part of the county passes through Pocotaligo Swamp. The drainage of the eastern part of the county has its outlet principally through Black and Lynches rivers. These streams are crooked and sluggish and the drainage is rather slow after heavy rains.

The State was divided into districts at an early date, and the first permanent settlement in Sumter District took place about the year 1750 in that part of the district now known as Salem. The settlers came principally from Virginia and North Carolina. These people were mostly of Scotch descent and a few came directly from Scotland. The greater part of the negro population is found in the flat country. The present population is composed principally of direct descendants of the early settlers.

Transportation facilities are about as satisfactory as in any county in the State. Railroads cross the county in almost every direction. These belong to the Atlantic Coast Line, the Southern, and the Northwestern of South Carolina systems, and afford direct transportation to Columbia, Augusta, Charleston, and Wilmington.

The chief town in the county is Sumter, which is the county seat, with a population of 10,000 or 12,000. Forty-six trains pass in and out of this town daily, which makes it a fine distributing point for jobbing, wholesale, and manufacturing establishments. Sumter is situated almost in the center of the county and receives the bulk of the trade. Mayersville, Wedgefield, and Hagood are small towns, but all of them have large business interests.

CLIMATE.

The climate of Sumter County is that of the warm temperate zone, and many plants that are adapted to a semitropical climate are found growing here. Crops generally suffer more from an excess of moisture

than from droughts; especially is this the case in the flat part of the county, where the water table is near the surface. There is a slight climatic difference within the boundary of the county. The crops in the level part of the area are about a week or ten days earlier than in the western part or the High Hills of the Santee. A good many people go to these hills to spend the summer.

The winters are mild and the snowfall very light, and many flowers and vegetables grow almost the entire year.

The day temperatures in summer are frequently high, but the nights are generally cool.

The following table shows the normal monthly, seasonal, and annual temperature and precipitation at the Weather Bureau station located in Stateburg.

Normal monthly, seasonal, and annual temperature and precipitation at Stateburg, S. C.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches
December.....	47	75	6	3.0	2.5	2.0	0.2
January.....	45	78	12	3.4	2.5	2.9	1.0
February.....	49	80	3	4.2	1.5	7.3	3.9
Winter mean.....	47			10.6	6.5	12.2	5.1
March.....	55	87	30	3.7	4.4	4.2	Trace.
April.....	62	91	32	3.1	1.4	3.0	0.0
May.....	72	101	44	3.3	3.1	1.7	0.0
Spring mean.....	63			10.1	8.9	8.9	Trace.
June.....	77	100	53	4.9	5.4	18.4	0.0
July.....	79	104	59	5.0	4.8	3.6	0.0
August.....	78	105	58	5.4	2.1	7.5	0.0
Summer mean.....	78			15.3	12.3	29.5	0.0
September.....	74	99	42	3.2	2.0	4.8	0.0
October.....	64	89	33	3.1	2.0	3.0	0.0
November.....	54	84	21	2.1	0.9	1.6	0.0
Fall mean.....	64			8.4	4.9	9.4	0.0
Annual.....	63	105	3	44.4	32.6	60.0	5.1

AGRICULTURE.

Sumter County was formed in 1798, but it was probably thirty or forty years before this date that a beginning in agriculture was made. The first settlers were herdsmen, who moved their cattle from place

to place as the range suited them. Later the great pine forests offered more profitable opportunities than agriculture, and large quantities of tar, turpentine, rosin, staves, shingles, lumber, etc., were produced in addition to beef, pork, and hides. The first crops grown were principally corn and wheat, both of which were grown in large quantities. Some indigo was also grown in the early days and exported, the English Government offering a bounty for its production. East India competition and the war with the mother country stopped this industry. Until about 1850 wheat and oats were extensively produced, but soon after this date cotton became the leading crop of the county, which position it has held to the present time. Rice was grown prior to the civil war along the streams or in the depressions, though only enough was produced to supply home demands. Very little rice has been grown since the war. Sugar cane has never been grown on a commercial scale, though small patches are found here and there, the sirup being made for home use.

A great change in agriculture was brought about by the war. The large number of cattle and hogs were no longer raised and the acreage in wheat was reduced to almost nothing. Cotton became the chief crop and the subsistence crops were practically abandoned. With an increase in production of cotton came a decrease in price. This state of affairs went on, conditions growing worse, until about 1892, when cotton reached such a low price that many farmers became bankrupt.

The conditions of agriculture differ markedly in different parts of the county. In the western or hill section more important development took place before the war and many old mansions are found there to-day. Their owners had large plantations in the lowlands of the State, but lived here most of the time on account of the more healthful climate. They used the Wateree Swamp for raising large numbers of cattle and hogs. These hills were also considered fine for nearly all kinds of fruits, principally peaches, figs, grapes, and small fruits. After the war agriculture in this section was almost prostrated and many years elapsed before it recovered. During this period of recovery agriculture made steady gains in the more level country, as it was thought that the lands there were more productive on account of their virgin condition and black color. The soils of the hills were subject to erosion and in many places the fields during abandonment had been washed badly, and this tended to retard growth here as compared with the progress in the lowlands. The flat lands were covered with extensive pine forests, which in places were cut for lumber, but in many cases the trees were felled and burned in order to get the land in condition for crops. At the present time the greater part of the farming is done in the level country, although the hills are gradually being improved, and most of the more productive soils, where well drained, are at the present under cultivation. Here,

however, there are some areas that have been abandoned for virgin soils. There are also thousands of acres covered with heavy forests of pine, cypress, and hardwood that can not be cultivated in their present state.

As a whole, farming practices are gradually improving. More attention is being paid to fertilization, the rotation of crops, and the maintenance of productiveness of the soil in general. It is the opinion that with careful attention to these matters much larger crop yields and greater net profit may be realized by the farmers; that is, the soils are capable of marked improvement and have not been cropped to their full capacity.

In the last ten years land values have almost doubled. The best land at the beginning of this period could be bought for \$20 to \$40 an acre; now it brings \$40 to \$75. The poorly drained soils, such as the Portsmouth fine sandy loam and Portsmouth sandy loam, bring \$10 to \$15. The Sandhill, which used to sell for 50 cents to \$1, is now bringing \$4 to \$5.

In size the farms vary from about 25 to several thousand acres. Most of the smaller farms are all under cultivation, while the larger holdings consist of tracts of waste land or land where the drainage conditions prohibit cultivation in their present state. According to the last census the average size farm contains 61.5 acres. In the census enumeration, however, each tenancy was considered a distinct farm, and the figures given are therefore too low. There is a growing tendency to divide the larger holdings, and the number of small farms has increased since 1900.

In 1899, at the time of taking the last census, Sumter County contained about 899 square miles. Since that time 312 square miles have been cut off and added to Lee County. The census figures relating to agriculture are, therefore, speaking roughly, about 33 per cent too large. They nevertheless give a general idea of the conditions in this county. According to this authority the number of acres in farms was 405,675, and the value of farm lands and improvements, excluding farm buildings, was \$3,663,330. There were 71,020 acres planted in corn, and 93,598 acres in cotton, producing 48,485 bales. The greater part of the remainder of the cultivated land was in oats, potatoes, cowpeas for hay, and garden crops. The expenditures for fertilizers amounted to \$221,300 and for labor \$323,290. The one-third to be deducted from these figures to allow for loss of territory has probably been offset in great part by the increase in land values and in the acreage of crops in the eight years since the taking of the census.

About 26 per cent of the farms of the county are operated by the owners. Where this is done labor is hired by the season, from January 1 until the crop is laid by, and paid from \$10 to \$18 a month—the

higher rate near the towns. After laying by the crops, most farm labor is hired by the day, in which case wages range from 50 cents to 75 cents without board.

Cotton is usually chopped and hoed by the acre, the price ranging from 30 cents to 50 cents per acre. Tenant farming done under the share system is less common than in other sections. The usual method is to rent the land for cash, the rentals ranging from \$2 to \$10 per acre, depending on the productiveness of the soil. The tenants are generally furnished their supplies by the merchants, who take a lien on the prospective crop and on the stock used in its cultivation. The landowner always receives his rent first. The majority of the tenants are negroes. They generally cultivate about 25 acres for each horse owned. Most of this they put in cotton and the remainder in corn, with occasionally an acre or two in oats and a small patch of sugar cane and sweet potatoes. A good many negroes own their farms and are in a prosperous condition, although as a rule their soils are not the most productive.

The low prices of cotton in 1897 and for several years prior thereto compelled the farmers to look for some other money crop. As a result tobacco was introduced. It proved profitable and was grown for a few years, but soon afterwards the prices of cotton advanced and the acreage of tobacco rapidly decreased. In the vicinity of Mayesville and Shiloh the farmers are still including a few acres in their crop system, as it is the general opinion that low-priced cotton and low-priced tobacco do not generally oppress the farmer at the same time.

New farmhouses, schoolhouses, churches, and buildings of every description show that the farmers of Sumter County are most prosperous and by using the up-to-date methods there seems to be no reason why this condition should not continue. Some of the farmers are practicing the most scientific methods, involving the rotation of crops, the use of modern machinery, and the economical use of fertilizers. These men no longer depend entirely on cotton for their income and grow in addition to the money crop those necessities which so many buy. The tendency has no doubt set generally in this direction, though progress is by no means so rapid as it should be. With such a variety of soils as is found in Sumter County, one should be able to carry on almost any line of farming desired. Very little attention has been given to the raising of live stock, though there are lands that could be utilized more profitably for this purpose than in any other way. Some farmers produce enough meat and corn for home use. A great many, however, do not produce enough of these commodities to carry them through the winter, while others purchase almost all their home supplies. The Portsmouth soils and the Wateree Swamp, composed of Congaree loam, afford good grazing

through the summer months, and peavine hay could be produced in great abundance. Bermuda grass does well on most all of the soils. The sandy soils are especially adapted to truck, although at present they are little used for this purpose, not enough being grown for home consumption. There is an excellent opportunity for this industry and dairying. The Norfolk soils would also grow fine grapes, and the Orangeburg soils fine peaches.

The lighter soils require much more fertilizer than the heavy ones to produce the same yields. The fertilizer in most common use is an 8-3-3 grade. If all the farmers would mix their own fertilizers according to methods recommended by the Department of Agriculture they could save money. The amount applied per acre ranges from 300 to 1,500 pounds, but it is not thought economical to use more than 1,000 pounds per acre for the crops grown at present. Many of the farmers apply from 50 to 200 pounds of nitrate of soda to the cotton as a top dressing.

Seed selection is an important matter, and those who have given it special attention find that it pays handsomely and that they can sell at good prices any surplus left after planting. Attempts to grow the long staple Upland cotton have generally met with success for the first one or two years, but unless great care is taken to keep the seed pure the staple soon deteriorates as a result of hybridization with the ordinary Upland varieties.

The methods of cultivation are practically the same as those throughout the cotton belt. The corn is almost all planted between the ridges instead of on the ridges. Then as cultivation proceeds the soil is turned to the corn. This keeps the roots deep in the ground, where the moisture conditions, especially in the sandy soils, are better. Cotton is generally cultivated on one side at a time instead of both. This is especially advantageous after the plants have attained some size, as the roots on one side have time to recover before the others are disturbed by cultivation.

The county roads are in very good condition and much interest is being taken in their improvement. The best road material available is composed of sand and clay. Good roads are being rapidly extended to all parts of the county. Artesian wells of excellent flow are secured in the eastern part of the county, at a depth of from 75 to 200 feet. These wells are great conveniences and could be used for irrigation on a small scale if desired.

SOILS.

Sumter County comprises three groups of soils which occupy distinct physiographic divisions. The soils found in these are markedly different in origin. In a general way the most of the western part of the county is upland, locally known as the High Hills of the Santee,

though they parallel the Wateree River. These hills are composed principally of the Lafayette formation. This formation is characterized by sand, gravel, and sandy clay, varying in color from brick red to pink, purple, orange, yellow, or white. Small deposits of quartz and quartzite gravel occur in many parts of this formation, and some ferruginous sandstone is also found. In road cuts or in erosions on hillsides layers of white kaolitic clays are often found. Four types of soil are derived from this formation, as follows: Orangeburg clay, Orangeburg sandy loam, Orangeburg sand, and Orangeburg coarse sandy loam.

A general line drawn almost north and south a little east of Wedgefield separates the hill country occupied by the Lafayette formation from the level country classed by geologists as the Columbia. The deeper stratum of this latter formation is a yellow sandy clay, frequently mottled with iron stains. The surface material is composed of light to dark colored sands and sandy loams, with textures varying from coarse to fine. The texture follows the topographic features very closely. The material is coarser on the higher elevations, gradually becoming finer as the elevation decreases. This is probably due to the removal of the finer particles by wash. It is this formation that gives rise to the Norfolk and Portsmouth soils. The following are the types established: Norfolk sandy loam, Norfolk fine sandy loam, Norfolk sand, Norfolk coarse sand, Portsmouth sandy loam, and Portsmouth fine sandy loam.

The third division comprises the overflow lands, the formation belonging to the Recent age. The greater part of these deposits occurs along the Wateree River, although comparatively large areas are found along Pocotaligo Swamp, Black River, and Lynches River. The soil material found along the Wateree River differs from that along the other streams in that it has been brought down from the Piedmont, while the other deposits are derived locally.

The Orangeburg coarse sandy loam is a type that is seldom found in other areas where the Lafayette formation occurs. This soil may be considered a gradation from the hill soils to the soils of the more level part of the area. It lies as a strip between the hills and the Norfolk coarse sand or Sandhill. The red clay found in the subsoil and which probably formed a part of the entire formation as laid down has doubtless been washed from the higher elevations and mixed with this white sand, giving it a reddish color and causing it to be slightly sticky. The Orangeburg sandy loam as it occurs in other areas is generally a hilly or rolling type and much subject to erosion, but the greater part of it in Sumter County is almost level or slightly rolling. The soil also seems to contain more fine material than is typical, thus giving it a more loamy texture. The greater proportion of the Norfolk sand also varies somewhat from the true

type. The clay substratum is only from 3 to 5 feet below the surface, while in other areas it is generally at a much greater depth, and the surface of the greater part of the type is almost level or slightly rolling, whereas in other areas it is generally rolling. These differences give the soil greater power to hold moisture, and it is therefore a little more productive than the Norfolk sand found in other areas.

The following table gives the names and extent of the several types of soil:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Norfolk sandy loam.....	82,240	21.8	Norfolk fine sandy loam.....	13,824	3.7
Portsmouth sandy loam.....	56,000	14.9	Orangeburg sandy loam.....	12,160	3.2
Congaree loam.....	42,816	11.4	Norfolk coarse sand.....	9,024	2.4
Portsmouth fine sandy loam.....	38,208	10.2	Orangeburg coarse sandy loam..	8,064	2.2
Swamp.....	35,136	9.4	Orangeburg clay.....	6,784	1.8
Norfolk sand.....	32,064	8.6	Total.....	375,424	.....
Orangeburg sand.....	24,896	6.6			
Sandhill.....	14,208	3.8			

NORFOLK SANDY LOAM.

The Norfolk sandy loam consists of a surface soil of coarse to medium gray or dark sandy loam with an average depth of 7 inches. Immediately below this is a light sandy loam having a slight yellowish color and extending to an average depth of 12 to 15 inches, though sometimes it reaches to 24 inches. Often the material is almost a sand and becomes lighter in color as the depth increases. The darker color of the soil is due to the presence of organic matter, and its depth and color depend on the depth of plowing and the crops to which it has been planted. Frequently the darker material does not extend more than 3 inches below the surface. The true subsoil, which occurs at a depth of 12 to 24 inches, is a yellow sandy clay.

The Norfolk sandy loam is found scattered over the greater part of the county, although the largest areas occur northwest and west of Sumter. The greater proportion of it is found along the stream courses in strips varying in width from one-eighth mile to 1 mile. Its surface is almost level, but varies in places to slightly rolling. One area in the extreme northeastern corner of the county has a rolling topography and the soil is in many places subject to erosion. Owing to position along the streams it has good drainage, except here and there in depressions, but even in such cases there is fall enough to the stream to make drainage a simple matter. Along the streams the soil forms a kind of terrace from 6 to 20 feet above water level. Generally the elevation decreases as the stream is left, until the poorly drained Portsmouth soils are reached.

With the exception of the Norfolk fine sandy loam the Norfolk sandy loam, as a rule, is a better soil than any of the other types of the flat section of the county. Those areas west and northwest of Sumter are possibly a little better drained than in other sections of the county.

As is generally true of the sandy loam types of this area, the material from which this soil is derived is a Coastal Plain deposit of sand and clay, the difference between the texture of surface soil and subsoil having been brought about by the removal of the finer clay particles in the drainage waters.

In sections where this soil occurs it is generally about the only cultivable land, although it is sometimes associated with the Norfolk sand and Norfolk fine sandy loam, both of which are well-drained soils.

The Norfolk sandy loam is very easily cultivated, and only in exceptional cases is the subsoil reached in plowing. The soil varies somewhat in productiveness, the differences depending mainly in the method of cultivation and the depth of the sandy surface material. Where it is from 10 to 12 inches deep the land is more desirable and can be improved more rapidly than where it is deeper, as it is less leachy and maintains a better moisture supply during a dry season.

It ranks with the best soils of the county for general farming and is especially adapted to cotton, corn, and oats, though also well suited to all kinds of truck. Cotton yields from one-fourth to 1 bale per acre, corn from 15 to 35 bushels, and oats from 40 to 65 bushels. The yields vary widely with the methods of cultivation and the quantity of fertilizer used.

The following table gives the average results of mechanical analyses of the Norfolk sandy loam:

Mechanical analyses of Norfolk sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17630, 17632.....	Soil.....	2.2	16.0	10.3	34.8	16.1	15.7	5.4
17631, 17633.....	Subsoil.....	2.4	14.0	6.3	25.6	12.9	17.7	21.0

NORFOLK FINE SANDY LOAM.

The Norfolk fine sandy loam, to a depth of 8 or 10 inches, is a dark-gray fine sandy loam. This grades into a yellowish fine sandy loam containing less organic matter. At about 15 inches is found the yellow sandy clay subsoil, which continues to 3 feet or more. The sand content is mainly of the finer grades. Iron concretions of a brownish-yellow color are sometimes found in the subsoil. Along the streams the subsoil in places has a yellowish-red color,

approaching that of the Orangeburg sandy loam subsoil. A similar variation is noted in the Norfolk sandy loam. In both cases it is believed to be due to better drainage and consequent more perfect aeration. The Norfolk fine sandy loam is the heaviest soil of the Norfolk series, although there is no difficulty in cultivating it. It occasionally breaks up into clods when plowed a little too wet, but these are easily pulverized by means of a light harrow.

Practically all of this type of soil occurs between Pocotaligo Swamp and Black River, following these streams and their tributaries. In mode of occurrence it is very similar to the larger part of the Norfolk sandy loam—that is, it parallels the streams as ridges or terraces. These ridges generally form the most of the cultivable land in the section where they occur, as the surrounding soil is principally Swamp or poorly drained Portsmouth soils. In years of average rainfall the Norfolk fine sandy loam is well drained. Open ditches are used to aid in draining the lower lying areas and to carry off excess water after rains. Near the streams there is little difficulty in finding an outlet for the water, as the land lies generally from 6 to 12 feet above the stream level.

Though occupying a comparatively small area this soil is an important one, as it is both productive and easily improved. It is fine in texture, which makes it less leachy than the more open soils. It seems especially fine for oats. It yields from one-half to 1 bale of cotton and from 25 to 60 bushels of corn. These larger yields are secured from land in a very high state of cultivation. Practically all of the type is under the plow, although some of it has been only recently cleared and the fields are still filled with stumps.

The following table gives the results of mechanical analyses of the soil and subsoil of the Norfolk fine sandy loam:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17638.....	Soil.....	0.5	3.4	3.8	60.1	16.9	11.5	3.3
17639.....	Subsoil.....	.4	3.4	2.5	46.5	17.6	13.0	16.4

NORFOLK SAND.

The soil of the Norfolk sand consists of about 6 inches of light-gray sand, varying in texture from coarse to medium, below which is a white or yellowish-white sand of practically the same texture extending to the depth of 3 feet or more. In one respect the Norfolk sand is unlike that found in other areas; the clay subsoil is not so far from the surface, the depth of the sand remaining close to that point which separates the Norfolk sand from the Norfolk sandy

loam, the subsoil becoming slightly tenacious between 30 and 40 inches. In many places where this soil has been properly cultivated it is quite loamy, but on the other hand there are occasional elevations that contain very little organic matter, and here the soil is thin and unproductive.

Nearly all of the Norfolk sand lies west of Pocotaligo Swamp. The greater part occurs in one broad area, which, beginning a little north of Sumter and taking in the greater part of that town, extends south to the county line.

The topography of the Norfolk sand is generally level, with here and there a gently rolling area. The drainage is good and in many cases is so thorough that the crops suffer from drought. The moisture conditions, however, are better than in many other areas of this soil, because of the almost level surface and the presence of the clay at a depth of 3 to 5 feet. For this reason it is more productive than in most other areas. Another reason for its productiveness is found in the generally good methods used in its cultivation. Five or six years ago the type was considered almost worthless, but since that time heavy applications of fertilizers have been made, often as much as 1,000 and 1,500 pounds per acre, and as a result from one-half to three-fourths bale of cotton per acre is secured. Where heavy fertilization has not been practiced the average yield is one-eighth to one-fourth bale. Corn yields on the average from 8 to 30 bushels, and the yield of oats ranges from 15 to 30 bushels per acre.

The native vegetation on the Norfolk sand is principally longleaf pine and scrub oak. Nearly all of the type is under cultivation at the present time.

NORFOLK COARSE SAND.

The surface soil of the Norfolk coarse sand consists of about 6 inches of a light-gray medium to coarse sand. Below this is a few inches of almost white sand which gradually passes into a light-yellowish sand, extending to a depth of 3 feet or more. The darker color of the surface soil is due to the presence of a small quantity of organic matter. The newly cleared lands contain considerably more organic matter than the average field, but under cultivation, except where organic manures are used, it is retained for only a few years.

The Norfolk coarse sand covers only a limited area, and is of little agricultural importance. It may be considered a gradation between the Norfolk sand and the Sandhill. It is confined to the western and southwestern sections of the county and is always associated with Sandhill. It is practically the only cultivable land along the edge of the Sandhill region varying from level to gently rolling, and is

more productive than the Sandhill, which has more pronounced relief. This type is badly in need of humus, and organic manures, together with heavy applications of fertilizers, are necessary to make it produce fair yields. Practically all of this soil has been under cultivation at one time or another. Where forested it usually supports a growth of longleaf pine and scrub oak. Practically all of the pine timber of any size has been cut.

Cotton and corn are the principal crops, although a small acreage is sown to oats. Cotton yields from one-eighth to one-fifth bale and corn from 4 to 7 bushels per acre. With heavy applications of barnyard manure and fertilizers one-half bale of cotton may be produced, and from 8 to 12 bushels of corn. The yields are almost directly proportional to the quantities of fertilizer applied.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Norfolk coarse sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17640.....	Soil.....	1.7	38.7	21.6	22.3	5.1	6.7	4.7
17641.....	Subsoil.....	2.2	46.2	21.4	18.4	4.1	5.1	2.8

ORANGEBURG SANDY LOAM.

The Orangeburg sandy loam consists of 5 to 15 inches of medium to coarse, gray or reddish-brown sandy loam, resting on a subsoil of pale-red to red sandy clay in which are occasionally mingled small iron concretions and quartz gravel. The lighter colored areas have a tendency to be rather loose and incoherent; the areas of reddish-brown soil are heavier, more compact, and in depressions frequently resemble a loam in texture. The nearer the clay subsoil approaches the surface the more loamy and the darker the soil. Areas where the sandy loam covering is more than 15 inches deep have been mapped as Orangeburg sand. Where the depth to the subsoil is 12 or 15 inches the first 5 or 6 inches is loamy, but the material between this and the true subsoil is frequently very open in texture, and more a sand than a sandy loam. The subsoil varies somewhat with the topography; the lower lying areas are of a pale red and the color becomes more intense as the elevation increases until it is a brick red. The subsoil of the more elevated areas also seems to contain more sand. The texture of this soil makes cultivation very easy.

The most extensive occurrence of this type of soil is in the north-western section of the county. It is found in comparatively large, scattered areas. The topography varies from almost level to rolling, the greater part, especially the larger areas, being gently rolling. It

is found in the hills that extend across the western side of the county and is associated with the Orangeburg clay and Orangeburg sand.

There is a considerable difference in the agricultural value of this soil, the more level areas producing much better yields than the rolling areas. This is due mainly to the greater depth of the sandy material in the rolling areas and also to erosion. In the hills the depth to the subsoil ranges from 10 to 15 inches, while in the more level areas the depth is generally 6 to 10 inches.

All of the Orangeburg sandy loam is well drained, although occasionally a depression of a few acres is found where artificial drainage is necessary. Such places are very productive and the soil is darker and more loamy.

The Orangeburg sandy loam is derived from the Lafayette sands and clays. It is one of the best types in the area for general farming, especially where the topography is only gently rolling. The original timber growth was principally hardwood, such as oak and hickory, with a scattering of pine. Practically all of the soil is now under cultivation. Cotton yields from one-half bale to 1 bale per acre, oats from 30 to 60 bushels, and corn from 20 to 40 bushels.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Orangeburg sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17644.....	Soil.....	1.9	13.5	11.0	27.8	19.0	14.2	12.9
17645.....	Subsoil.....	2.3	10.6	5.2	14.5	6.5	16.5	43.8

ORANGEBURG SAND.

The soil of the Orangeburg sand consists of a medium to coarse sandy material, varying in depth from 12 or 15 inches to about 25 inches. The first 3 or 4 inches, owing to the presence of a small quantity of organic matter, is more loamy than the soil below this depth and has a grayish color, but the color quickly changes to yellowish or reddish brown and the loamy texture becomes less and less pronounced with depth until an incoherent sand is found. The subsoil is a red sandy clay, with a comparatively open texture, but becomes heavier as the depth increases. When the subsoil reaches within 12 or 15 inches of the surface it becomes quite heavy at depths between 25 and 36 inches. Frequently rounded quartz pebbles are found in the soil, and iron concretions are scattered through the subsoil. The subsoil is almost the same as that found beneath the Orangeburg clay and Orangeburg sandy loam, with the exception that it seems to contain a little more sand and occurs at a greater average depth.

Beginning $1\frac{1}{2}$ miles north of Wedgefield the Orangeburg sand extends in an almost continuous strip across the northwestern part of the county. The area varies in width from about $1\frac{1}{2}$ miles to 4 miles and is about 14 miles in length. It is broken only occasionally by very small areas of other soils, principally Orangeburg sandy loam and Norfolk sand. There are numerous included spots, a few acres or less in extent, where erosion has taken place, that would have been mapped as Orangeburg clay had they been large enough to represent on a map of the scale used in the survey.

The Orangeburg sand has the most rolling topography of any soil in the county. It occupies the greater part of the high hills of the Santee, and the most elevated parts of the county are composed of this soil. Many narrow and deep valleys traverse the areas. The drainage is always adequate and on the slopes washing and gullyng often take place, leaving exposed the underlying red clay and rendering necessary the abandonment of occasional fields. Terracing and contour cultivation are necessary over the greater part of the soil, although on hilltops some comparatively large level areas are found. The Orangeburg sand is derived from deposits of the Lafayette age.

The timber growth varies somewhat with the depth of the sandy surface material. The principal growth on the very sandy areas is longleaf pine and scrub oak. Where the clay is nearer the surface some shortleaf pine and a good growth of hardwood are found.

Much of the area of this soil is cultivated with difficulty. The productiveness and general agricultural value vary with the depth of sandy material. Cotton yields on an average about one-fourth to one-half bale, corn from 10 to 20 bushels, and oats from 20 to 30 bushels per acre. Larger yields than those stated can be produced when the land is carefully handled and heavily fertilized.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Orangeburg sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17642.....	Soil.....	2.5	13.5	8.9	38.6	22.5	10.4	4.2
17643.....	Subsoil.....	2.6	12.9	5.9	22.4	16.4	8.5	30.8

ORANGEBURG COARSE SANDY LOAM.

The Orangeburg coarse sandy loam has a texture between a true sand and a sandy loam, and may be best described as a light sandy loam. It is a dark-brown or reddish-brown coarse sand to a depth of 10 inches with just enough clay mixed with it to give it a slightly tenacious character. The structure is very open and each grain seems to

be composed of an individual particle of sand with the slightest quantity of clay surrounding it. The subsoil is almost identical with the soil, although it is a little lighter in color and occasionally seems to be a little more tenacious. The type is remarkably uniform and varies only along the margin of areas, where it grades into other soil types.

The Orangeburg coarse sandy loam is in a practically continuous strip about $1\frac{1}{2}$ miles wide, beginning a little west of Manchester and extending north for about 12 miles past Wedgefield. The surface is nearly level and the drainage is good, as the open structure of the soil permits the rapid percolation of water. Occasionally it is necessary to drain small depressions.

The Orangeburg coarse sandy loam is derived from the Lafayette formation, but has never been encountered until mapped in the present survey. It is a very distinct type and apparently represents a gradation between the Norfolk and Orangeburg soils. The eastern margin of this type is formed by Sandhill or Norfolk coarse sand areas, while the western side is bordered by the "red hills" or Orangeburg soils. It would appear that the Orangeburg coarse sandy loam results from the mixture of the red clay brought down from the hills and with the white sand of the level areas. In wells an almost pure white sand is found at depths between 10 and 15 feet.

From the general surface appearance of this type one would take it to be a good soil, as it lies well and has the dark color usually indicative of productiveness. The texture, however, is too open to hold fertilizers, and the soil is badly in need of vegetable matter. Practically all of the Orangeburg coarse sandy loam is under cultivation. The yields are comparatively small, although larger than those of the Norfolk coarse sand and Sandhill. Better results seem to be secured with oats than with any other crop, the yield ranging from 20 to 30 bushels. Corn does fairly well—10 to 20 bushels per acre—and cotton yields from one-fourth to one-half bale per acre. During dry seasons the yields fall below those stated. Heavy applications of fertilizers are necessary to profitable cultivation.

The Orangeburg coarse sandy loam originally supported a rather scrubby growth of oak.

The results of mechanical analyses of the soil and subsoil are given in the following table:

Mechanical analyses of Orangeburg coarse sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17646.....	Soil.....	2.9	41.5	13.5	16.2	2.8	7.5	12.7
17647.....	Subsoil.....	4.4	33.4	13.0	13.8	3.5	8.2	23.4

ORANGEBURG CLAY.

The Orangeburg clay consists of less than 4 inches of brown or reddish-brown sandy loam, varying in texture from medium to fine, overlying a stiff red sandy clay carrying small gravel and iron concretions. As the type has resulted from erosion there is found considerable variation in the different areas, in places the clay subsoil coming to the surface, and in others the mixing of the clay and sandy veneer giving a true loam. Areas having a layer of sandy loam exceeding 4 inches in depth were mapped as Orangeburg sandy loam or Orangeburg sand. Frequently at a depth of 2 or 3 feet the subsoil becomes more sandy. The sand varies from medium to coarse in texture and consists of rounded grains. It is likely that at one time all of this clay had a covering of sand or sandy loam.

Areas having the first few inches a sandy loam are easily cultivated, as the plowing as a rule is not deep enough to reach the underlying clay. Where the clay lies at or near the surface the land is more difficult to handle. When broken it forms clods and must be harrowed thoroughly to put it in good tilth. If plowed too wet it bakes very hard. This changes the structure of the soil and some time is required to get it back to its proper condition. In texture this soil is the heaviest of the upland types.

The Orangeburg clay occurs in one large and a few scattered areas. The large area lies near the town of Wedgefield and parallels the Wateree Swamp. It is between 6 and 7 miles in length and from one-half to 2 miles broad. The smaller areas are erosions on the slopes and appear in the Orangeburg sand areas. This type is locally known as the "red lands" and forms a part of the High Hills of the Santee.

The topography varies from almost level to hilly. Going west across the large area the increase in elevations is gradual, but there is an almost abrupt drop when the Wateree Swamp is reached. The level areas occur along the eastern edge. The soil has excellent drainage.

The Orangeburg clay constitutes one of the best cotton and general farming soils of the Gulf and Atlantic Coastal Plains. It stands a drought or excess of moisture better than most of the soils. It is retentive and the effects of fertilizers are lasting. The greater proportion of the area of the type in Sumter County is under cultivation. The original timber growth was principally hardwood. The chief crop is cotton, yielding from one-half to 1 bale or more per acre, corn from 20 to 50 bushels, and oats from 25 to 40 bushels per acre.

The following table shows the results of mechanical analyses of the Orangeburg clay:

Mechanical analyses of Orangeburg clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17648.....	Soil.....	1.4	18.9	7.6	23.6	13.0	17.1	17.6
17649.....	Subsoil.....	1.0	12.2	6.5	17.6	9.8	13.2	38.7

PORTSMOUTH FINE SANDY LOAM.

The soil of the Portsmouth fine sandy loam, which is from 6 to 12 inches deep and of a rich dark color, is composed of fine and very fine sand and a large quantity of organic matter. The line between the soil and subsoil is usually well marked, the dark color stopping abruptly as a rule where the gray or yellow color begins. For a few inches the subsoil is composed of a very fine sand of gray color containing little organic matter. As the depth increases the sand content becomes less and is displaced by fine silt and clay, resulting finally in fine sandy clay. In the lower depths the subsoil varies in color from yellow to mottled yellow and gray and is stained with iron. The Portsmouth fine sandy loam and the Portsmouth sandy loam are very similar and have about the same topography, being generally flat and poorly drained. Small ponds and swampy places are scattered throughout the areas, and drainage must be provided before much of this type can be profitably cultivated. Owing to this poor drainage condition and the presence of large quantities of decomposing organic matter the soil is quite acid and requires liming.

Areas of this soil usually support a forest of pine, cypress, bay, magnolia, various water-loving oaks, and grasses. Practically all of the Portsmouth fine sandy loam occurs in the eastern part of the county, east of Pocotaligo Swamp, where it forms broad basinlike areas. The largest area is found between this stream and Black River.

When brought under cultivation this soil generally produces good yields during dry years, but frequently fails during years of more than average rainfall. The cultivated portions are generally found around the edges of the large areas, the elevation being slightly higher than in the interior and the drainage therefore better. It is difficult to estimate the probable yields on this soil, as the typical areas are not generally cultivated. The type is better adapted in its present condition to grazing than to growing cultivated crops.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Portsmouth fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17652.....	Soil.....	0.8	4.2	10.6	45.7	2.2	25.7	10.0
17653.....	Subsoil.....	.0	5.7	4.0	36.2	13.4	20.4	19.7

PORTSMOUTH SANDY LOAM.

The Portsmouth sandy loam, locally known as the "Pine Flats," consists of about 8 inches of black sandy loam, containing a large quantity of organic matter, resting on a mottled clay frequently showing red iron stains. The soil is variable, however, and often extends to a depth of 4 inches only, where a gray sandy clay is reached, this grading into the mottled sandy clay. On the other hand, the soil may consist of about 15 inches of peaty sandy loam largely vegetable matter. Along Turkey Creek, which lies principally within the town limits of Sumter, a small area of this soil was mapped. Here the material to a depth of 3 feet was almost a muck. The first 20 or 25 inches was black; below this it was a little lighter in color. This is practically the only difference in the soil and subsoil. This area has been drained, and had it been large enough it would have been mapped as another type. The sand in this type of soil is rather uniform, being mainly medium in texture with some of a coarser grade. The phases of the type are generally found in small areas. Excepting the Orangeburg clay, the Portsmouth sandy loam is the most difficult of the upland soils to cultivate, as it is generally rather wet and sticky.

The Portsmouth sandy loam is found in scattered areas throughout the county. It generally occurs as depressions or basins, the larger areas being found between stream courses. Along the edges of the streams there is usually an elevated soil well drained and suitable for cultivation, such as the Norfolk sand, Norfolk sandy loam, and Norfolk fine sandy loam. The Portsmouth sandy loam and the Portsmouth fine sandy loam comprise practically all the undrained areas of the county. The former frequently occurs in areas too small to represent on the map. Areas known locally as savannas have been classified as this type. They occur as depressions in well-drained soils and contain water the greater part of the year. Such places are comparatively small and are rarely ever cultivated, as they require drainage.

The greater part of the cultivated area lies along the edges of the broad areas, or where small depressions have been drained. Only

small areas have been drained. It is the general opinion that with drainage the soil would be the most productive in the county. This opinion is based largely on the yields secured from small drained depressions. It is improbable that the soil of the broader areas is as productive, although it is very good land. In its undrained condition it gives fair grazing during the summer, though little used for that purpose. The timber growth is practically all pine.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Portsmouth sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
17650.....	Soil.....	2.6	14.2	9.6	30.3	16.7	19.4	7.8
17651.....	Subsoil.....	2.4	17.0	8.8	24.8	8.4	18.3	19.4

CONGAREE LOAM.

Under the type name of Congaree loam has been included the swamp land along the Wateree River. Naturally the soil, which has been laid down by the river, has a wide variation in texture, depth, and drainage possibilities. However, as most of this land is unsuitable for agriculture on account of poor drainage it was not deemed advisable to attempt to make any separations in the soils. At the State farm a part of this land has been reclaimed from overflow by diking. All of this type is represented on the map with a swamp symbol with the exception of this State farm tract.

The color of the soil of the different phases of the Congaree loam consists of different shades of brown and the texture varies from a sandy loam to a clay. The greater the elevation, the lighter the color and the higher the content of sand. There is frequently a narrow terrace along the stream that is well drained. Here the soil to a depth of 10 inches is a brown heavy sandy loam containing particles of mica. From 10 to 36 inches the material is a little lighter in color, but slightly more tenacious, and occasionally a very fine seam of sand is found. The soil becomes darker in color and heavier in texture as the elevation decreases. The soil of the lower lying areas consists of about 10 inches of brown clay, underlain by a brownish-yellow clay of practically the same texture. The mica in this phase is seldom very noticeable. Occasionally places are found where the terraces above referred to have been cleared and were at one time under cultivation. Practically all of the soil has been abandoned for farming purposes. This is principally due to the overflows, which seem to have been more frequent in recent years than they were formerly. A large part of the cleared land is covered with a growth of Bermuda grass, to which the soil seems well adapted. At

present the land can be used most profitably as pasture. Along the small streams that enter this swamp there is generally a slight terrace. Between the river terrace and the bluffs or uplands is a broad, flat basin intersected by streams, lakes, and sloughs. There are occasionally small elevations scattered here and there through this basin. If the Congaree loam could be drained and protected from overflow it would be one of the most valuable soils in the State, but in the majority of cases the expense would be too great to make present reclamation economical. The State farm produces from 50 to 75 bushels of corn and from 65 to 90 bushels of oats per acre. Land composed of the Congaree loam is valued according to the timber growth and the ease with which lumbering can be carried on. It supports such valuable trees as cypress, oak, and hickory. The less desirable gum, beech, and cottonwood also flourish. The greater proportion of the area is owned by lumber companies, which are rapidly cutting the merchantable timber.

SWAMP.

The areas mapped as swamp are found along the streams and the soil is formed largely of local material, thus differing from the Wateree Swamp, in which the deposits have come from the Piedmont. The Swamp soil is rich in organic matter and is generally covered by water the entire year. It can not be used for agriculture unless it is drained. The areas are narrow and follow the streams, the largest occurring along Pocotaligo Creek and Black River, along which streams the areas reach a mile in width. The Swamp is an unimportant soil and occupies only a small proportion of the county. If drained it would become productive.

SANDHILL.

In the Sandhill the first 1 or 2 inches contains enough organic matter to give the soil a light grayish color. Below this to a depth of 3 feet or more the sand is almost pure white or a very light cream color. The texture of both soil and subsoil varies from medium to coarse. Occasional rounded gravel deposits are found in roadcuts at a depth of 6 to 8 feet below the surface.

In surface features the areas of Sandhill vary from almost level to rolling. Frequently they have the form of wind-heaped, irregular ridges, hillocks, or small dunes. These are in many cases bare of vegetation, and the sand is so white that at a distance they appear to be snow banks. On a close examination it will be found that the first half inch or inch of sand has been thoroughly washed by the rains and that below this for 1 or 2 inches the sand is slightly darker. Bare spots are very numerous throughout the Sandhill areas, and wherever they are found the surface is almost pure white.

The Sandhill is confined entirely to the southwestern corner of the county. It appears about $5\frac{1}{2}$ miles northeast of Manchester and extends in a broad body in a southwesterly direction across the county. It is most typically developed in the vicinity of Manchester. The main body varies in width from one-half mile to 4 miles and has a length of about 9 miles.

The Sandhill is excessively drained, and its lack of moisture-holding properties is one of the principal causes of its low agricultural value. The only areas cultivated are occasional fields in depressions or narrow strips bordering the streams. Such places contain a little more organic matter and are capable of holding a little more moisture when first cleared. Such spots will occasionally produce from one-fourth to one-half bale of cotton per acre, but in two or three years the yields drop to half this. Practically all the efforts to cultivate the Sandhills have met with failure.

The timber growth is rather scattering and consists of scrubby oak and longleaf pine. Nearly all the pine timber of any market value has been cut. A little grass, principally broom-sedge, grows in scattering patches, and this is about the only vegetation, aside from the scrubby forest growth.

SUMMARY.

Sumter County lies in the eastern-central part of South Carolina and comprises an area of 375,424 acres or about 587 square miles. The surface features vary from hilly in the northwestern part to gently rolling or level in other parts of the county.

Sumter County was organized in 1798, but settlement took place long before this date.

While the greater portion of the well-drained land is now under cultivation, the county affords good opportunities for the homeseeker.

Cotton is the dominant crop, and while corn, oats, and hay are grown, the production is not nearly sufficient to meet the local demands.

Very little attention is given to stock raising and thousands of dollars worth of meat are shipped in annually.

Potatoes and truck crops, sugar cane, peanuts, sorghum, peaches, and grapes are minor crops.

The chief town and county-seat is Sumter, with an estimated population of 10,000 or 12,000. Forty-six trains pass in and out of this town daily, which makes it one of the finest distributing points in the State for jobbing, wholesale, and many other establishments.

The price of agricultural lands, as well as all other real estate, has increased greatly within the last few years, owing to the stimulation of high prices for cotton. The towns have rapidly increased in population in the last ten years.

The Orangeburg soils are found principally in the hilly section and are derived from the Lafayette formation. The Norfolk and Portsmouth types occur in the level sections and are derived from the Columbia formation. The Congaree loam, an alluvial soil bordering the Santee River, is recent in origin.

The Norfolk sandy loam, the best soil of the series, is one of the most important types of the county. It is well drained and is readily improved. It is not only well adapted to cotton, corn, oats, and cowpeas, but it is an excellent soil for truck, although but little used for this purpose.

The Norfolk fine sandy loam has as many good qualities as the Norfolk sandy loam, with the exception that it is not quite so good for truck. It is especially adapted to oats and is a good cotton and corn soil. It covers only a comparatively small area.

The Norfolk sand extends over a large area, but being deep and porous it is droughty and only fair yields can be produced even where heavy applications of fertilizers are used. It could best be utilized for truck growing.

The Orangeburg clay and Orangeburg sandy loam are the two best soils in the county for cotton, corn, and oats. They are also well adapted to the growing of peaches.

The Portsmouth soils, Swamp, and Congaree loam are generally poorly drained and their greatest value is for grazing.

Excellent flows of artesian water are found in certain sections of the county.

With the mild climate, excellent transportation facilities, and a great variety of soils, almost any line of agriculture may profitably be carried on in Sumter County. The growing of peaches, grapes, pecans, peanuts, and asparagus are important agricultural industries that might be developed extensively, as the soils are especially adapted to them.

SOIL SURVEY OF LEE COUNTY, SOUTH CAROLINA,

By FRANK BENNETT, G. W. TAILBY, Jr., JAMES L. BURGESS, W. J. LATIMER, and H. L. WESTOVER.

DESCRIPTION OF THE AREA.

Lee County, S. C., is situated in the north central part of the State, and entirely within the Coastal Plain. It is bounded on the north by Darlington, Chesterfield, and Kershaw counties, on the west by Kershaw and Sumter counties, on the south by Sumter County, and on the east by Darlington and Florence counties.

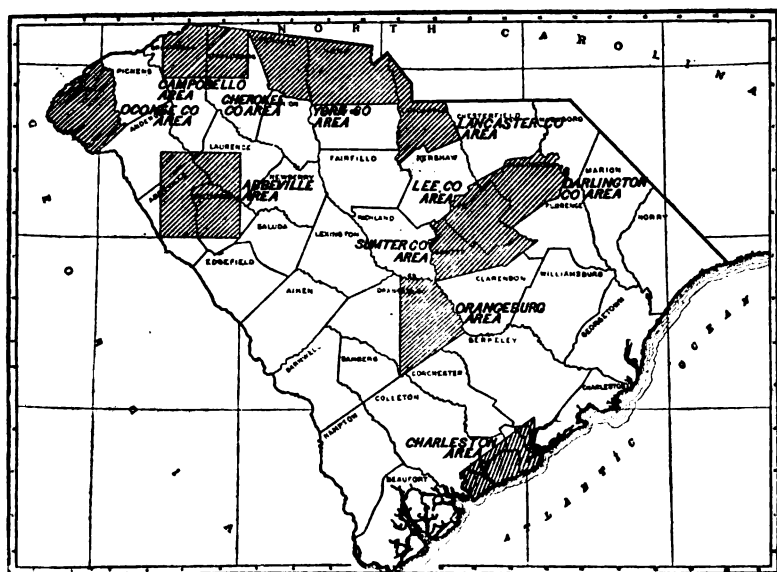


FIG. 10.—Sketch map showing location of the Lee County area, South Carolina.

The surface varies from flat to hilly, the flat areas being poorly drained. A line drawn northeast and southwest through the town of Bishopville, on the east side of Lynches River, separates in a general way the hill country from the flat country, the hills lying to the north and west of this line.

As one passes north the elevation increases until the hills are reached, the rise being nowhere abrupt, but a gradual upward sweep.

The hills have good drainage, being cut by V-shaped valleys. In the Sandhill sections the hills rise to considerable height and are very steep. In general, the southern part of the county is poorly drained, although ridges from 6 to 20 feet in elevation follow the stream courses. These ridges are well drained and suitable for cultivation. The elevation of St. Charles is 165 and of Elliott 169 feet above tide. These are the only definite elevations available, and both towns are in the southern part, where the country is lowest. In the hills the elevation above Bishopville probably reaches 300 or 400 feet.

The main streams of the county flow almost south. The eastern side of the county is drained by Lynches River, which follows a very tortuous channel. Its tributaries are very small, except in the northern part, where the drainage from the Sandhill areas enters. The drainage of the central part has its outlet principally through Black River, while that of the western part is carried off through Black River and Scape Oer Swamp. Cowpen Swamp also drains a part of the southwestern corner, but Scape Oer Swamp, which rises just at the northern edge of the county, probably carries more of the drainage waters of the county than any other stream. Most of the streams have their sources in the hill country. In the southern part of the county they become very crooked and sluggish, so that the drainage of this section is slow.

South Carolina was first divided into districts, and Lee County was included in Sumter district. The first settlements took place about the year 1750 along Lynches River. The settlers came principally from Virginia and North Carolina, but a few came directly from Scotland. The present population is composed largely of direct descendants of these early settlers.

The transportation facilities are fairly good. They are better in the southern than in the northern part of the county. All of the railroads belong to the Atlantic Coast Line system. There are two lines crossing the southern part of the county, almost parallel to each other and about 5 miles apart. The line passing through Lynchburg is a main line; the one passing through Elliott extends from Sumter, S. C., to Fayetteville, N. C. At Elliott there is a branch line passing through Bishopville, its eastern terminus being at Lucknow.

The county roads, as a general rule, are fair. Some in clay areas are difficult to travel in the winter, and others in the region of the Sandhills are very sandy. Much interest has been taken in the building of good roads in the last few years and the road system is rapidly being extended and improved. Road material is at hand in the shape of the sandy clay which underlies the region.

The chief town of the county is Bishopville, the county seat, with a population between 2,000 and 2,500. It is situated a little east of the center of the county. This town has been the county seat only

since 1902, has made a wonderful growth, and has many new public and private buildings. It is the only town of any size and receives the bulk of the trade, although other smaller towns, including Lynchburg, do a good business. Some of the trade in the southwestern part of the county goes to Sumter, which is nearer this section than Bishopville.

CLIMATE.

The climate of Lee County is mild and equable. Sometimes the temperature drops below freezing, but such a condition only lasts for one or two days. The summer days are frequently quite hot, but the nights are usually very pleasant, especially in the hill section. The growing season is long and vegetables can be grown during almost the entire year. The crops in the flat section of the county are generally about a week in advance of those in the hill section.

The rainfall is ample for all crops and is well distributed throughout the year. As there is no Weather Bureau station in Lee County, the figures given below are taken from the records of the station at Stateburg, in the adjoining county of Sumter, and represent fairly well the climatic conditions of Lee County.

Normal monthly, seasonal, and annual temperature and precipitation at Stateburg, S. C.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.
December.....	47	75	6	3.0	2.5	2.0	0.2
January.....	45	78	12	3.4	2.5	2.9	1.0
February.....	49	80	3	4.2	1.5	7.3	3.9
Winter mean.....	47			10.6	6.5	12.2	5.1
March.....	55	87	20	3.7	4.4	4.2	T.
April.....	62	91	32	3.1	1.4	3.0	0.0
May.....	72	101	44	3.3	3.1	1.7	0.0
Spring mean.....	63			10.1	8.9	8.9	T.
June.....	77	100	53	4.9	5.4	18.4	0.0
July.....	79	104	59	5.0	4.8	3.6	0.0
August.....	78	105	58	5.4	2.1	7.5	0.0
Summer mean.....	75			15.3	12.3	29.5	0.0
September.....	71	99	42	3.2	2.0	4.8	0.0
October.....	61	89	33	3.1	2.0	3.0	0.0
November.....	54	84	21	2.1	0.9	1.6	0.0
Fall mean.....	64			8.4	4.9	9.4	0.0
Annual mean.....	63	105	3	44.4	32.6	60.0	5.1

Dates of first and last killing frosts.

Year.	Stateburg.		Year.	Stateburg.	
	Last in spring.	First in fall.		Last in spring.	First in fall.
1898.....	Apr. 28	Nov. 25	1903.....	Apr. 5	Nov. 7
1899.....	Apr. 5	Dec. 5	1904.....	Mar. 16	Oct. 24
1900.....	Apr. 1	Nov. 9	1906.....	Apr. 24	Oct. 11
1901.....	Mar. 22	Nov. 16	Average.....	Apr. 6	Nov. 12
1902.....	Apr. 9	Nov. 28			

AGRICULTURE.

Lee County was formed in 1902 from parts of Sumter, Darlington, and Kershaw counties, the greater portion being taken from Sumter County.

Before 1750 the region was traversed by herdsmen who raised great numbers of cattle, moving from place to place as the range suited them. These people generally drove their cattle from farther north into this section for the winter, as the cane and other grasses afforded excellent grazing during this season.

To the first settlers the products of the pine forests seemed to afford a better means of livelihood than a direct tilling of the soil, so they brought in breadstuffs and clothing and exported large quantities of tar, turpentine, rosin, staves, shingles, lumber, beef, pork, and hides. The first crops were corn and wheat, which were produced in large quantities. Some indigo was also grown in the early days, as the English Government offered a bounty for its production.

Until about 1850 corn, wheat, and oats were extensively cultivated, but after that date cotton became the principal crop, and still holds first place. Some rice was grown prior to the civil war, but very little has been produced since that date. The principal markets in the early days, before the railroads were built, were Cheraw, on the Pee Dee River; Camden, on the Wateree, and Charleston. Lynches River has never been navigable except for flatboats, which, after the civil war, were used on this stream for carrying turpentine.

A great change in the agriculture was brought about by the civil war. Cattle and hogs were no longer raised on a large scale, and wheat was not grown to any great extent. Cotton became the chief crop on account of the high price.

The greater part of the farming, especially on the large estates, was formerly done along the edge of the hill country, and many of the old colonial homes are still in use. These soils, known as the "red lands," produced fine yields, especially of wheat. Large quantities of fruit, such as peaches, figs, grapes, and small fruits, were also grown. This hilly section had good drainage, which made it more healthful than the southern part of the county. After the war, as the country

became more thickly settled, the better drained land in the southern part began to be cleared. Originally most of it was covered by a heavy growth of pine, which was cut down and some of it used for lumber. The rest was burned off in order to clear the land for cultivation. During the early period of agriculture many fields were continuously cultivated until they failed to produce satisfactory yields and were then abandoned for newly cleared untouched soils. The greater proportion of the more productive and well-drained soils are at present under cultivation, although a few fields have been abandoned for virgin soil. There are also thousands of acres covered by a forest of pine, cypress, gum, and some hardwood, which, if cleared, would not be fit for cultivation unless proper drainage were established.

At one time, when land was cheap and plentiful, the farmer could afford to cultivate one field until the soil was worn out, then abandon it and clear up new land for cultivation. Now that the county has become more thickly settled and land values have increased, it is no longer practicable to follow the wasteful and careless methods of the past. Hence the farming practices are gradually improving, and a more economical and intelligent system is being introduced and adopted. More attention is being given to rotation of crops and the use of fertilizers in the effort to maintain the productivity of the soil and to realize larger crop yields. In the last ten years land values have more than doubled; the most productive land now brings from \$40 to \$75 an acre, the poorly drained soils, such as the Portsmouth series, from \$10 to \$15, and the Sandhill soil from \$3 to \$5. Some of the land near Bishopville can not be bought for less than \$100 an acre.

The size of the farms varies from about 25 to several thousand acres, and the larger farms are being divided into smaller holdings. Most of the smaller farms are generally under cultivation, while the larger ones frequently include many acres of waste land or land unsuited for cultivation in its present condition.

As Lee County was formed and organized since the census of 1900, no official data are available in respect of total acreage and production of the main crops. As the greater part of the new county was taken from Sumter County, it is safe to say that the agricultural conditions in the two are practically the same and that from the figures given in the last census for Sumter County a general idea may be formed as to the relative importance of the crops grown in Lee County.

Less than one-third of the farms are operated by the owners. Where the owner does operate the farm labor is hired by the day or month, the prices paid per month ranging from \$10 to \$18, with rations. Practically all of the work is performed by negro labor.

Many of the farmers give these laborers a few acres of land to cultivate free. When employed by the month, the general custom is to hire laborers from January or February until the crops are laid by, after which they are paid by the day as needed, the day wage ranging from 50 to 75 cents without rations, although sometimes during a busy season as high as \$1 a day is paid. For chopping and hoeing the cotton they are paid according to the acreage worked, the price ranging from 30 to 50 cents per acre. The share system of farming, though quite general throughout the South, is not practiced so much in this county as in other sections of the cotton belt. It is also true that very little land is rented for a stipulated amount of cotton. The most general method of renting is for cash, the prices ranging from \$2 to \$10 an acre, according to the productivity of the soil. Under the share system the landlord furnishes everything necessary to make the crop except one-half of the fertilizers and the labor, and receives one-half of all the crops produced. The tenants are generally furnished their supplies by the merchants of the local towns, who are secured by liens on the crops and such stock as the tenant happens to possess. The landowner always receives his rent first. The majority of the tenants are negroes, who generally cultivate about 25 acres to the horse—15 or 20 acres in cotton, and the remainder in corn. Occasionally they will have 1 or 2 acres in oats or small patches of sugar cane, sweet potatoes, etc. A good many negroes own their farms and are in a rather prosperous condition. Much of the labor has left the rural districts for the near-by towns and cities. The lumber companies have drawn considerable labor from the farms. The present available supply of labor is scant, and its cost has about reached the limit which the farmer can pay and realize a satisfactory profit under the system of growing crops now followed.

The low price of cotton in 1897 and for several years prior thereto compelled the farmers of the county to introduce some other money crop along with cotton. For this purpose tobacco was grown. It seemed profitable for a few years, but soon after its introduction the price of cotton advanced, and the acreage of tobacco rapidly decreased. In the vicinity of Lynchburg the farmers are still cultivating a few acres to this crop, as it is the general opinion that cotton and tobacco are not generally low priced at the same time.

There is noticeable improvement in the homes and farm buildings throughout the county, which as a rule are comfortable and ample, and this alone shows that the county is in a prosperous condition.

Some of the farmers do not depend on cotton entirely, but are practicing scientific rotation of crops, using modern labor-saving machinery, and raising home supplies. These are the farmers who are generally

in the best financial condition. This kind of farming is gradually spreading, and when it becomes general the agriculture of the county will have taken a long step forward.

With a mild climate and a variety of soils, Lee County affords opportunities for almost any character of farming. Too little attention has been given to the raising of live stock, though much land could be utilized more profitably for this purpose than in any other way. While some farmers raise enough meat and corn for their own use, a great many do not produce enough of these products to carry them through the winter, and others purchase almost all of their home supplies.

The areas of Portsmouth soils and Swamp afford good grazing from early spring to late fall, and with the use of cotton-seed meal and pea-vine hay during the winter cattle raising should be profitable. The increased supply of manure would be a great advantage, especially on the lighter soils, where the effects of fertilizers are not lasting. The sandy soils, such as the Norfolk sandy loam, Norfolk fine sandy loam, and Norfolk sand, are especially adapted to early truck, although they are used for this purpose only to a slight extent, not enough being grown for home consumption. There is an excellent opportunity for this industry and dairying. The Orangeburg soils and the Norfolk sandy loam in the hilly section of the county should prove excellent peach soils. Most of the soils of the county are adapted to pecan growing, and although it takes several years to receive any returns from the trees, they pay handsomely when they begin to bear, which is from five to seven years.

The fertilizer most commonly used is an 8-3-3 brand. The farmers are beginning to mix their own fertilizers, and by so doing they save several dollars a ton. The quantity applied per acre ranges from 300 to 1,500 pounds, but it is not thought to be economical to use over 1,000 pounds per acre. A few farmers apply half of the total quantity of fertilizer to be used before the crop is planted and the other half after the crop begins to grow; besides this, 50 to 200 pounds of nitrate of soda is frequently used as a top dressing. This method is highly recommended, especially on the very sandy soils, where the fertilizer is easily leached out. Where large quantities are applied three applications would probably prove beneficial. The results from these methods would depend to a large extent on the amount of rainfall during the growing season. The study of the application and kinds of fertilizer to be used in growing certain crops on a given soil is deserving of care and attention. Those farmers who give special attention to the proper selection of seed for planting find that it pays well. Some attempts have been made to grow the long-staple Upland cotton, and it has generally been successful for

one or two years. When it is planted with the short staple and no attempt is made to keep the seed pure, it soon deteriorates, and the returns from the sale are not much greater than those of the short-staple cotton.

The methods of cultivation are practically the same as those found throughout the cotton belt of the South. The corn is usually planted between the ridges instead of on the ridge. In cultivating the crop the soil is turned to the corn, and thus when laid by the plant occupies a ridge. This method keeps the roots deep in the ground, which aids them in reaching the moisture, and also makes it easier to cover up the grass. There is, however, one slight disadvantage in this method. When the corn is small and heavy rains occur on the sandy soils the sand frequently washes down into the furrow and covers the corn, while on the heavy soils in the very flat areas the water remains in the furrows, sometimes until the plant is killed or badly damaged.

It would seem that where the drainage is not especially good it would be better to have the corn slightly elevated rather than in the furrow, as these are the soils that suffer most from a wet season. The cotton is generally cultivated on one side at a time instead of both, as is the custom in many sections. This is especially advantageous after the plant reaches a good size, as all the roots are not disturbed at once, those on one side having time to recover before those on the other side are cut.

The use of the one-horse plow in preparing the soil for planting is very general, and in cultivating the crops it is also used to do the bulk of the work. A more general use of the two-horse plow and other improved forms of farm machinery would reduce the cost of production. The soil as a general rule is plowed to a depth of 4 to 6 inches. It should be plowed deeper, increasing the depth 1 or 2 inches each year until 8 or 10 inches is reached. If the proper methods were practiced by all of the farmers of Lee County, as is done by some, it would not be necessary to open up new lands for a number of years. The present cleared lands can be improved much more cheaply than the virgin lands can be put under cultivation after clearing. It is also true that it costs as much to cultivate an acre of land that produces one-fourth or one-half bale of cotton as it does an acre that produces a bale. Improving the soil so that it will produce greater yields and using improved farm machinery will aid greatly in solving the labor problem.

SOILS.

A line drawn across the county through Mechanicsville and Bishopville in a general way separates it into areas occupied by two distinct geological formations. On the north the Lafayette is found and on

the south side the Columbia. The former takes in the hilly section and the latter the level and poorly drained section. The principal types derived from the Columbia are the Norfolk sandy loam and Portsmouth sandy loam. There are also small areas of Norfolk sand and Portsmouth fine sandy loam. The subsoils of this section of the county are composed of yellow or mottled sandy clays frequently spotted with red iron stains. Below these clays, at a depth of 10 to 40 feet, is a water-carrying stratum of quicksand. The flows of well waters usually come from this sand, which is white and rather fine. The surface material is composed of sands and sandy loams, the texture varying from coarse to fine and the color from light to very dark gray. The texture and color follow the topographic features very closely, the lighter colored and coarser material being found on the higher elevations, but gradually becoming darker in color and finer in texture as the elevation decreases. This is due to the fact that the finer material has been removed to the lower levels and to the accumulation of organic matter. The lighter colored soils belong to the Norfolk series, while the darker ones at a lower elevation belong to the Portsmouth series. The hills in the western part of the county are an extension of the "High Hills of the Santee," which cross Sumter County, although the Lafayette formation is not typically developed in Lee as in Sumter County, and the red clay gradually gives way to a yellow or reddish-yellow clay. The Orangeburg sand and Orangeburg sandy loam are locally known as the "red lands." The Orangeburg sandy loam in Lee and Sumter counties in some respects is unlike that found in other areas. As found elsewhere, its topography is generally hilly or rolling and the soil seems to have been subject to erosion to a considerable extent, whereas in these two areas it is almost level or gently rolling and seems to contain more fine material. Thus a more loamy texture is imparted to it. Moreover, in many places the clay subsoil does not seem to be as red and does not contain so much sand as is generally found in other areas.

The Orangeburg sandy loam appears to be a broad gradation between the level country and the hills. It was often difficult to determine the line of separation between this type and the Norfolk sandy loam, as the change in the color of the subsoil was so gradual. The Norfolk sand in Lee County is typical of that found in most other areas, though it is not so loamy in texture or level in topography as that found in Sumter County. In the northern part of the county are found the Sandhills, which occupy only a very small part of a vast sand ridge occurring in South Carolina and the neighboring States. These sands in many places are very white and comparatively pure, and must have been subjected to severe wave and wind action.

Ten types of soil were mapped in Lee County. The name and extent of each are given in the following table:

Areas of different soils.

Soil.	Acres.	Percent.	Soil.	Acres.	Percent.
Norfolk sandy loam.....	79,616	30.2	Sandhill.....	13,248	5.1
Portsmouth sandy loam.....	62,464	23.6	Norfolk fine sandy loam.....	3,584	1.3
Orangeburg sandy loam.....	29,696	11.3	Portsmouth fine sandy loam.....	1,152	.3
Swamp.....	27,904	10.6	Orangeburg coarse sandy loam.....	192	.6
Norfolk sand.....	27,904	10.6			
Orangeburg sand.....	17,068	6.4	Total.....	262,848	.....

PORTSMOUTH SANDY LOAM.

The Portsmouth sandy loam has quite a wide variation, but as it is one of the poorly drained soils of the area it was impossible to separate the different phases. As a general rule the soil to a depth of 6 to 8 inches is a black sandy loam containing large quantities of organic matter. The subsoil is a gray or mottled clay, frequently having red iron stains because of the decomposition of iron concretions. The soil often extends only to a depth of 4 inches, where a gray sandy clay is encountered which grades into a mottled sandy clay; or again, the soil may consist of about 15 inches of sandy loam carrying a very high percentage of vegetable matter. In some instances the subsoil is almost a gray sand containing just enough clay to make it sticky. The texture of the sand is rather uniform, being medium, although some fine and coarse sand is found, and it is frequently the case that the texture along the edges of the area is influenced by that of the surrounding soil. The elevation also has something to do with the character of the soil, the lighter colored and more sandy phase being found at higher levels, and the soil becoming darker, more loamy, and richer in organic matter as the elevation decreases. These phases generally occur as small spots, but they are numerous and scattered. This type is about the most difficult of the upland soils to cultivate, as it is generally wet and rather sticky.

The Portsmouth sandy loam is found in isolated areas over the southern half of the county, practically all of it west of Lynch River. It generally occurs as depressions or broad basins. The larger areas are found as basins between the stream courses. Along the edges of the streams a higher lying soil, the Norfolk sandy loam or Norfolk sand, is usually found, and back from these ridges is the poorly drained Portsmouth sandy loam locally known as the pine flats. This type and the Portsmouth fine sandy loam and Swamp comprise the undrained soils of the area. The so-called "savannas,"

which have been classified with this type, occur as depressions within areas of well-drained soil, and contain water the greater part of the year. Such places are comparatively small and require drainage, which is generally very expensive. The only growth in these savannas consists of various kinds of water-loving grasses.

The Portsmouth sandy loam is cultivated mostly along the edges of the broad areas or where small depressions have been drained. The latter are very productive, and it is the general opinion that if drainage were provided the type would be, on the whole, one of the most productive in the county. These spots, however, of a few acres have received the drainage from surrounding soil for many years, and this has added greatly to their productivity and it is doubtful if the soil in general would prove as good. The soil is frequently acid and has to be treated with lime to overcome this condition. The native vegetation on this type is frequently burned off, and in this way the soil is needlessly deprived of large quantities of organic matter. The soil affords good grazing during the spring and summer, but it is used to a very limited extent for this purpose. The timber growth is practically all pine, with a scattering of cypress, gum, and here and there scrub oak. It is hard to estimate the crop yields, as so little of the soil is under cultivation, and that generally cultivated is not representative of the main areas. It should produce from one-quarter to three-quarters of a bale of cotton per acre and 20 to 30 bushels of corn. It seems better adapted to oats than any other crop. The yields depend entirely on the season. During a wet year the crops are almost a failure, and it is seldom the soil suffers from a lack of moisture.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Portsmouth sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17660.....	Soil.....	2.6	14.2	9.6	30.3	16.7	19.4	7.3
17651.....	Subsoil.....	2.4	17.0	8.8	24.8	8.4	18.3	19.4

PORTSMOUTH FINE SANDY LOAM.

The soil of the Portsmouth fine sandy loam is composed mainly of fine and very fine sand, with smaller quantities of silt and clay, which, with the unusually large quantity of organic matter, gives the soil a loamy texture. This material, which is dark in color, extends to a depth of 6 to 12 inches. Its structure is such as to promote good drainage, and the soil when free from roots and stumps is quite easily cultivated. It is slightly sticky when wet, and if plowed in this condition it sometimes forms clods, but these are broken without diffi-

culty. The change from soil to subsoil is usually well marked, the dark color as a rule stopping abruptly when the subsoil is reached. The first few inches of the subsoil are generally composed of a very light fine sandy loam of gray color, with a notable absence of organic matter, but as the depth increases the sand content becomes less, and is replaced by fine silt and clay, resulting in a subsoil of sticky fine sandy clay. In the lower depths the subsoil varies in color from yellow to mottled-yellow and gray, depending upon the aeration and drainage to which it has been subjected. The subsoil frequently contains iron concretions and is often stained with iron.

The Portsmouth fine sandy loam is similar to the Portsmouth sandy loam, the principal difference being in the texture of the sand. Small ponds and swampy places are of frequent occurrence in both soils, and drainage will be necessary before any considerable areas can be put under cultivation. Owing to its poorly drained condition and the large quantity of organic matter it carries, the Portsmouth fine sandy loam is frequently quite acid and requires treatment with lime. The native vegetation consists of pine, cypress, bay, magnolia, and various water-loving oaks and grasses.

The Portsmouth fine sandy loam is of very limited extent in Lee County, covering not more than 2 square miles. This type is found in the extreme southeastern part of the county. The two largest areas are along the county line and are continuations of broader areas in Sumter County, where the type is extensively developed. The other areas are near Lynch's River. In almost every case the type is surrounded by Portsmouth sandy loam. The cultivated areas are very small, being generally around the edges of the larger ones. Where cultivated, the land as a rule has been cleared in comparatively recent years and the fields often contain many stumps. This soil generally produces good yields during a very dry season, but crops are frequently almost a failure during a wet year. It is hard to estimate the yields, as so little of this type is cultivated, and the areas used are not representative. Like the Portsmouth sandy loam, it seems better adapted to oats than to any other crop. Practically the only use to which it can be put in its present condition is grazing.

NORFOLK SANDY LOAM.

The soil of the Norfolk sandy loam to a depth of about 8 inches consists of a coarse to medium gray or dark-gray sandy loam. Immediately below this is a light sandy loam, having a slightly yellowish color, which extends to a depth of about 20 inches. Frequently this subsurface material is almost a sand, and becomes lighter in color as the depth increases. The darker color of the soil proper is due to the presence of organic matter, and there is also a relation between the topography and the color, the lighter shades being found in the more

elevated areas. The true subsoil is composed of a yellow, sticky, sandy clay, sometimes containing iron concretions, which when decomposed cause reddish spots. Occasionally along the slopes near the streams there is a very narrow strip of land where the subsoil is a reddish-yellow sandy clay, the reddish color being due, it is believed, to better drainage and more thorough aeration. The average depth of the sandy material overlying the clay subsoil is from 10 to 15 inches.

This type of soil is very easily cultivated, except where the gravel content is high. It varies somewhat in productiveness according to the methods of cultivation employed and the depth of the sandy material overlying the clay subsoil. Where the surface soil is 10 to 12 inches deep it is more desirable than where it is 20 or 24 inches deep. In the former case it can be improved more rapidly, is better able to hold its fertility, and is capable of supplying more moisture during a dry season.

The Norfolk sandy loam is found in the southern part of the county, south of Bishopville, and also in the western and northwestern parts of the county, where it is more rolling and subject to erosion. In the southern part of the county the greater part of it occurs as narrow strips following the stream courses and varying from about one-eighth mile to 2 miles in width. Owing to its position along the streams, it has good drainage, although artificial drainage is sometimes necessary where there are depressions. There is no difficulty in getting fall enough in a short distance to give the excess water an outlet into the streams. Where the Norfolk sandy loam occurs as a kind of stream-terrace it has an elevation from 6 to 20 feet above the streams. The elevation generally decreases as the distance from the streams increases and as the poorly drained Portsmouth soils are approached. The Norfolk sandy loam, as a rule, is better drained than any other of the soils of the flat section of the county, with the exception of the Norfolk sand. In the southern part of the county it is drained for the most part by Black River and its tributaries, and in the western and northwestern parts its principal drainage is through Scape Oer swamp. As is generally true of the sandy loam types of Lee County, this soil has been derived from a Coastal Plain deposit of sand and clay, the smaller particles of clay having been removed or washed down, leaving the coarser material to form the sandy surface.

In those sections where the Norfolk sandy loam occurs it is the principal cultivable land, although it is sometimes associated with the Norfolk sand and Norfolk fine sandy loam, which are well drained soils adapted to agriculture.

The Norfolk sandy loam ranks among the best soils of the county for general farming. It is especially adapted for cotton, corn, and oats, and is also the best trucking soil of the area. Some portions of the type seem well adapted to fruit, especially peaches. The yields

depend upon the cultivation and quantity and kind of fertilizer used. Cotton yields from one-quarter bale to 1 bale per acre, corn from 15 to 40 bushels, and oats from 40 to 65 bushels.

The results of mechanical analyses of samples of this type of soil are given in the following table:

Mechanical analyses of Norfolk sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17636.....	Soil.....	1.9	23.7	16.5	32.9	10.0	9.9	4.6
17637.....	Subsoil.....	2.5	19.0	12.5	23.1	7.0	8.6	27.5

NORFOLK FINE SANDY LOAM.

The Norfolk fine sandy loam to a depth varying from 10 to 20 inches is a very fine sandy loam, underlain by a fine, sticky yellow loam subsoil. There is no sharp dividing line between soil and subsoil, but one gradually merges into the other. The top soil may contain a small percentage of coarse sand, but there is always a sufficient proportion of very fine sand and silt to give it the properties of a mellow loam. In the heavier phases the soil is slightly sticky even quite near the surface. The subsoil becomes heavier and more tenacious with depth.

The physical properties of the soil are further improved by the abundance of organic matter which it usually contains. Owing to its retentive nature this soil is more easily improved than the other soils of the area.

The Norfolk fine sandy loam is found entirely east of Lynches River and in that part of the county taken from Darlington and included in the Darlington County survey. There are three areas, which together cover only a few square miles. The largest area lies between Alcot and Stokesbridge, and the next largest is found around Cypress. The type occupies rolling slopes as well as stretches of level country, and varies slightly both as to texture and agricultural value. It is generally almost surrounded by Norfolk sandy loam, and the transition line between the two types is not clearly defined. As found in Lee County the soil contains more coarse sand than the greater part of that found in Darlington County, but the subsoil is typical.

The Norfolk fine sandy loam is recognized as one of the best cotton soils in the county, is well cultivated, and the yields are very satisfactory. As a result it is largely devoted to cotton, with corn of secondary importance, although some oats are grown. When properly tilled corn will yield from 30 to 40 bushels per acre and oats from

35 to 50 bushels. The best farmers expect a bale of cotton per acre, but the general average is probably less than three-fourths of a bale.

Cowpeas do especially well and are extensively grown on this soil. They are usually sown between the corn rows, and the vines are cut for hay after the corn has been harvested. About 1 ton per acre is the average yield of pea-vine hay. The original timber growth was principally pine, but practically all of it has been removed.

NORFOLK SAND.

The Norfolk sand consists of about 5 inches of light-gray sand, varying in texture from medium to coarse, underlain by white or yellowish-white sand of practically the same texture. The darker color of the surface soil is due to the presence of a small quantity of organic matter which rapidly decreases as the depth increases. In some places a yellow sandy clay, corresponding to that of the Norfolk sandy loam, is reached at a depth of 3 feet, but over the greater part of the type the depth to the clay is much greater.

The greatest extent of the type occurs in the northern and north-western section of the county, although there is a narrow strip following the eastern side of Scape Oer Swamp, which extends almost across the county. There is one large area on the eastern side of Lynches River following the edge of that swamp. This soil does not occur in uniform and extensive areas, but in rather scattered areas, and is associated with almost every other type of the county, but principally with the Norfolk sandy loam.

The Norfolk sand occurs on rolling hills and stream slopes and at varying elevations. The areas in the northern part of the county are more rolling than those in the southern and central parts, while the texture of the soil is coarser in the rolling areas. The drainage is naturally good.

Owing to the open structure and leachy character of this soil the yields of cotton and corn are light. Vegetables are produced for home use and to supply the local markets and the soil is better adapted to trucking than to general farming. It is an early soil and easily cultivated, but is badly in need of organic matter. The incorporation of vegetable matter would improve its texture and increase its moisture-holding properties. The larger part of the type is under cultivation. Cotton yields from one-eighth to one-quarter bale per acre and corn from 5 to 10 bushels. On the level or rather depressed areas the yields are better. The newly cleared areas generally produce fair yields for one or two years, but without proper fertilization the soil soon declines in productiveness. The original timber growth was longleaf pine and scrub oak.

ORANGEBURG SANDY LOAM.

The soil of the Orangeburg sandy loam consists of a gray or reddish-brown sandy loam varying in depth from 5 to 15 inches. The texture of the sand varies principally from medium to coarse, with the medium grade predominating. In the lighter colored areas the soil is inclined to be rather loose and incoherent, while in the reddish-brown areas it is heavier and more compact, and when found in depressions frequently resembles a loam in texture. Below the first few inches is found a somewhat lighter colored sandy loam, with a more open texture, due to a smaller content of organic matter. The subsoil to a depth of 3 feet or more varies from a red to a pale-red sandy clay, occasionally containing brown iron concretions and quartz pebbles. The nearer the clay is to the surface the more loamy is the soil and the darker the color. Where the sandy loam is less than 15 inches deep it has been mapped as Orangeburg sandy loam, and where it exceeds this depth it has been mapped as Orangeburg sand. Where the depth to the subsoil is 12 or 15 inches the first 5 or 6 inches of soil has a loamy texture, but in the remaining depth to the subsoil it is frequently of very open texture and more of a light-colored sand than a sandy loam, the organic matter decreasing and the color becoming lighter as the depth increases.

The subsoil varies somewhat with the topography. In the lower lying areas it is a pale red, and the color becomes brighter as the elevation increases, until it is a brick red. The subsoil in the more elevated areas also seems to contain more sand and iron concretions. Occasionally small pieces or slabs of ferruginous sandstone are found scattered through this soil.

The greater part of this type occurs as one broad and almost continuous area, which, beginning in the vicinity of Bishopville, extends in a southwesterly direction through Rosehill and across the county line into Sumter County. Its maximum width is about 15 miles. There is one comparatively large area on the eastern side of Lynches River around Ashland, and the remainder of the type is on the western side of this stream. The topography varies from almost level to rolling, the larger areas being gently rolling. The principal areas are found along the edges of the hills. On the western side the type is generally bordered by the Orangeburg sand or Norfolk sandy loam, while on the eastern side it is associated with the Norfolk sandy loam and Portsmouth sandy loam. Where associated with the Norfolk sandy loam the merging of the one soil into the other is frequently very gradual, and some difficulty was experienced in drawing the line of separation. There are a few small bodies of this soil found within areas of the Orangeburg sand and the Norfolk sandy loam. Where it occurs in the Orangeburg sand it is generally the result of erosion,

sufficient sandy material having been removed to bring the clay nearer the surface. Such areas are usually found along the slopes.

The agricultural value of this soil varies with the topography, the more level areas producing much the better yields. In the hilly or rolling areas the soil is subject to erosion, and the depth to the subsoil is generally from 10 to 15 inches, while on the more level areas the average depth is from 6 to 10 inches.

Most of this soil is well drained, although a depression of a few acres is occasionally found where artificial drainage is necessary. Such places are very fertile, and the soil is nearer a true loam than a sandy loam. The original timber growth consisted of hickory, pine, and oak.

The Orangeburg sandy loam is one of the most desirable soils in the State for general farming. It is very easily cultivated, although the smaller areas in the hills require terracing and contour cultivation. Practically all of this soil is farmed. Cotton yields from one-half to 1 bale per acre, corn from 20 to 40 bushels, and oats from 30 to 60 bushels. Where properly cultivated, the better areas will produce larger yields than mentioned above.

The results of mechanical analyses of samples of soil and subsoil of the Orangeburg sandy loam are given in the following table:

Mechanical analyses of Orangeburg sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17644.....	Soil.....	1.9	12.5	11.0	27.8	19.0	14.2	12.9
17645.....	Subsoil.....	2.3	10.6	5.2	14.5	6.5	16.5	43.8

ORANGEBURG SAND.

The soil of the Orangeburg sand consists of a medium to coarse sandy material, varying in depth from 12 to about 25 inches. The first 3 or 4 inches, owing to the presence of a small quantity of organic matter, is a light-gray sandy loam. This quickly changes to a yellowish or reddish-brown sand, the loaminess of texture decreasing as the depth increases. The subsoil is a red sandy clay of comparatively open texture, but where the subsoil is within 12 or 15 inches of the surface it becomes quite heavy at a depth between 25 and 36 inches. Frequently rounded quartz pebbles and iron concretions are found in both the soil and subsoil, although the concretions are generally more numerous in the subsoil. The subsoil is almost the same as that in the rolling areas of the Orangeburg sandy loam, with the exception that it seems to contain a little more sand and lies at a greater depth.

Practically all of the Orangeburg sand occurs in one broad area, broken only by Beaver Dam Creek, and small areas of Orangeburg

sandy loam. It extends in a northeasterly and southwesterly direction, is about 8 miles in length, and has a maximum width of about $4\frac{1}{2}$ miles. On the eastern side of this area is found the Orangeburg sandy loam, and on the western side the Norfolk sandy loam. In the Orangeburg sand are found frequent spots a few acres or less in extent, which would have been mapped as Orangeburg clay or Orangeburg sandy loam had they been large enough to represent on the map.

The Orangeburg sand occupies the greater part of the very hilly section known as the "Red Hills," which is composed of the Lafayette formation. The drainage is always adequate and often is excessive, erosion leaving exposed the underlying red clay and rendering necessary the abandonment of occasional fields. Terracing and contour cultivation are necessary on a large proportion of this soil, although some comparatively large level areas are found on the hilltops.

A considerable part of this soil still remains uncultivated and some of it is rather too steep for farming. The timber growth varies somewhat with the depth of the sandy material overlying the red clay. The principal growth on the very sandy areas is longleaf pine and scrub oak. Where the clay is nearer the surface some shortleaf pine is found and there is a better growth of hardwood.

The productiveness and agricultural value of the Orangeburg sand vary with the depth of the sandy surface material. Cotton yields on an average about one-fourth to one-half bale per acre, corn from 10 to 20 bushels, and oats from 15 to 30 bushels. The yields also depend on the methods of farming and the amount of fertilizer used, and larger yields than those given may be secured where the land is handled in the most approved way.

ORANGEBURG COARSE SANDY LOAM.

The soil of this type is a pale-red or orange-red coarse sand to a depth of 10 inches, with just enough clay mixed with it to render it slightly tenacious. The texture is very open and each grain of sand seems to be an individual particle with the slightest quantity of clay surrounding it. The subsoil is almost identical with the soil, although it is a little lighter in color and seems to be slightly more tenacious. The type is practically without a variation, except where it grades into other types.

The Orangeburg coarse sandy loam is extensively developed in Sumter County, but only one very small area was found in Lee County. It corresponds in most respects with that found in Sumter County, with the exception that the color is not so red. This small area occurs in the northern part of the county, north of Turkey Creek. In topography it is nearly level or slightly rolling.

The soil is very easily cultivated, has good drainage, and is practically all under cultivation. The crop yields are comparatively small, but they are better than those of the Norfolk sand. Oats seem to

yield better than any other crop, and corn does fairly well. Cotton yields from one-fourth to one-half bale per acre, corn 10 to 20 bushels, and oats 20 to 30 bushels. During a dry season the yields are apt to be decidedly reduced. With heavy applications of fertilizers and by incorporating vegetable matter this soil gives much better returns and the tendency to drought is lessened.

SANDHILL.

The first 1 or 2 inches of the Sandhill contain enough organic matter to give it a slightly gray or a dirty white color. Below this, to a depth of 3 feet or more, is an almost pure white or cream-colored sand. The texture of this sand in both soil and subsoil varies from medium to coarse. Occasionally deposits of rounded gravel are seen in road cuts at a depth of 6 to 10 feet below the surface.

The topography varies from hilly to gently rolling and the surface is often made up of irregular wind-blown ridges, hillocks, or small dunes. The hillocks or dunes are frequently almost devoid of vegetation and the sand is so white that from a distance they look like snowbanks. On a close examination of the bare spots it will be found that the first half inch or inch of sand has been thoroughly washed by the rains, which makes it very white, but below this for an inch or two the soil is darker.

The type is found principally in the extreme northern part of the county east and northeast of Lucknow. It occurs in rather broad and uniform areas, the largest of which is about $2\frac{1}{2}$ miles in width east and west and about 4 miles long. The most of it is found west of Lynches River, although there is one comparatively large area on the eastern side in the vicinity of Stokesbridge, which follows the swamp line for a distance of about 5 miles.

The Sandhill is excessively drained. Its low moisture-holding power is one of the principal causes of its small agricultural value. It is the most useless of the well-drained soils of the county, and cultivation is confined to occasional small fields in depressions or to narrow strips on each side of the stream courses, and these areas are not typical. Such places contain a little more organic matter, which aids in holding moisture.

They produce from one-fourth to one-half bale of cotton per acre when first put under cultivation, but it is only a matter of a few years until the humus is exhausted and the yields greatly reduced. Attempts to cultivate the Sandhills more extensively have met with little success.

The timber growth consists of longleaf pine and a very scrubby growth of oak. Practically all of the merchantable timber has been cut, although the production of turpentine is still carried on to a very limited extent. Some grass, principally broomsedge, is seen here and there.

SWAMP.

The Swamp occurs as narrow strips on each side of the stream courses, and is found mainly along Lynches River. There is some difference in the soil here and as found along the other streams of the county. The average soil along Lynches River is a very dark-brown loam, underlain by a clay or clay loam of practically the same texture but of a little higher color. Some areas are almost black and contain much sand.

There is a wide variation in this soil, as is generally the case in the Swamp type. The soil is generally a black loam or heavy sandy loam, underlain by a drab or dark sandy clay or clay loam. Lynches River has its source just in the edge of the Piedmont and considerable red sediment is brought down from the hills of that section and deposited. This is why the soil along this stream has a brighter color. Along the other streams the soil is derived entirely from local deposits.

The greater part of the Swamp is covered by water most of the year. If drained and cleared it would be a very valuable soil, but the expense of reclamation would be too great to make it practicable in view of the present prices. The native growth, which is rather dense, consists of gum, cypress, bay, magnolia, and other water-loving trees, vines, and grasses.

SUMMARY.

Lee County, situated in the north central part of South Carolina, lies entirely within the Coastal Plain.

It is a comparatively new county, being formed from Sumter, Darlington, and Kershaw counties in 1902, the greater part being taken from Sumter County.

The first settlement took place about 1750. The settlers came principally from Virginia and North Carolina, but a few came direct from Scotland. The present population is composed largely of direct descendants of the early settlers.

The topography varies from flat to hilly. The northern and western parts are rolling; the southern and eastern parts flat and poorly drained.

The principal crops are cotton, corn, oats, and cowpeas. There are many others that could be successfully grown. The Orangeburg sandy loam and Orangeburg sand are adapted to fruit, and especially to peaches and grapes. The Orangeburg sandy loam produces good yields of wheat, although this industry has practically been abandoned.

The soils of Lee County are derived from two distinct geological formations, the Lafayette and Columbia, the former covering the hilly section and giving the Orangeburg soils. The Columbia forms the flat country and furnishes the material of the Norfolk and Ports-

mouth soils. Ten types of soil, all light textured, easily cultivated sands or sandy loams, occur in the county.

The Orangeburg sandy loam is considered the best soil in the county for general farming, producing goods yields of cotton, corn, oats, and cowpeas, the latter used as hay.

The Norfolk sand and Norfolk sandy loam are excellent trucking soils, but not enough truck is grown to supply the local demand.

The Orangeburg sand is a fair soil, but the clay subsoil is so far from the surface that it is not as easily improved as some of the other soils. Peaches and grapes seem to do well, although so far the soil has been used very little for these products.

The Norfolk sandy loam is the most extensive soil and next to the Orangeburg sandy loam in agricultural value.

The Norfolk fine sandy loam has a comparatively small area. The yields of crops are very good.

The Norfolk sand is a deep, leachy, sandy soil, difficult to improve and producing only light yields.

The Portsmouth soils are poorly drained, and are not of any agricultural value in their present condition. Small areas are cultivated with good results. The land affords some grazing.

Sandhill is of practically no agricultural value. Occasional attempts have been made to cultivate it, but with little success.

With the variety of soils and mild climate, Lee County presents good opportunities for the homeseeker. Almost any line of agriculture may be followed.

SOIL SURVEY OF JEFFERSON COUNTY, FLORIDA.

By GROVE B. JONES, W. E. THARP, and H. L. BELDEN.

DESCRIPTION OF THE AREA.

Jefferson County is located about midway of the State east and west and extends from the Georgia State line on the north to the Gulf of Mexico on the south. Madison and Taylor counties bound it on the east and Leon and Wakulla counties on the west.

The shape of the county is that of a wedge about 25 miles wide east and west at the north boundary and narrowing to 5 miles at the southern extremity, while its extreme length north and south is about 40 miles. The county embraces an area of 374,592 acres, or about 585 square miles.

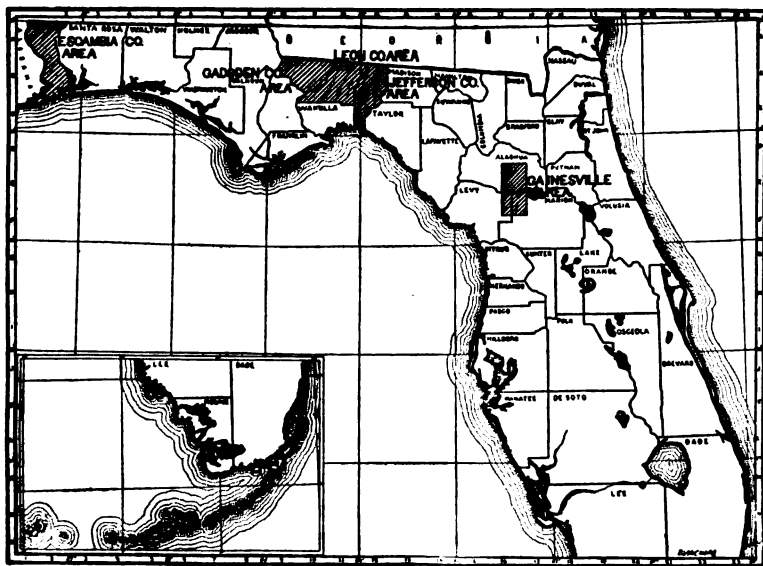


FIG. 11.—Sketch map showing location of the Jefferson County area, Florida.

The Aucilla River at some points forms a rather indefinite county boundary line. From Lamont north it is not at all times confined to a single channel, but frequently spreads out into an impenetrable swamp often a mile or so in width, or divides into numerous shallow, ill-defined channels. "Nuttall Rise," about 4 miles north of the point where the Aucilla River empties into the Gulf, is the last of a suc-

cession of sinks and rises which cover a distance of about 6 miles. Within this distance no definite county boundary line exists. The larger sinks have been mapped, and a line connecting them indicates approximately the underground course of the river and serves as the county boundary line in this survey.

The topographic features of Jefferson County are varied and interesting, owing to the two pronounced physiographic divisions within its borders. In a general way the dividing line separating these two provinces may be described as entering the county from the west just south of the point where the Tallahassee Southeastern Railroad (a part of the Seaboard Air Line system) enters. From this point it extends eastward, passing a little north of Wacissa, where it takes a southeast course until it leaves the county about 2 miles north of the Madison-Taylor county line. The larger division lies to the north and includes about two-thirds of the county. This part comprises the uplands and consists of rolling to gently undulating country interspersed with rounded hills, lakes, streams, and narrow valleys. The surface features are nowhere roughly broken, and with the exception of the swamps, no flat areas of any extent exist.

The altitude at Monticello is 202 feet, but it is believed that the highest elevation in the county is to be found in the northwest corner. At Drifton the elevation is 190 feet and at Lloyd 154 feet. Southwest of Aucilla a large, fairly flat area, known as Thompson's Valley, at one time evidently formed an arm of the sea.

The physiographic division covering the southern third of the country forms the "flat woods" and represents the poorly drained section of the county. Its surface features are marked by low swells with fairly level areas intervening. For the most part drainage is poorly developed, the channels are immature, and swamps and bays are numerous. The elevation varies from sea level to 45 feet at Wacissa.

Besides the larger streams the county is well watered with lakes and ponds, into which many of the smaller streams empty. The largest lakes are Miccosukee, Razor, Windom, Silver, and Iamonia. The Aucilla River and its tributary, Gum Swamp, drain the eastern and northeastern parts of the county, while the drainage of the western part finds its way into Lake Miccosukee and the St. Marks River. About 1 mile south of the town of Wacissa the beautiful Wacissa River has its source. A great volume of clear, sparkling water, boiling and surging from the earth through deep springs, forms a picturesque stream 150 to 200 yards in width. This river eventually reaches the Gulf through the Aucilla River.

The dissolution of the limestone which underlies the county as a whole at different depths has given rise to many peculiar and inter-

esting phenomena. The numerous natural bridges of the Aucilla River, the many lakes and sinks into which streams plunge and are lost, and the several "rises," where subterranean water surges to the surface, forming new streams, are all interesting. Northeast of Lloyd the outlet to Lake Miccosukee, which has at times become nearly dry, disappears through a small limestone orifice, at least 25 feet below the surface. A quarter of a mile south of Lake Sink, Mill Creek, a stream of considerable size, disappears in the same manner. In times of high water these two sinks become united through a channel normally dry. If the two orifices become closed or nearly so by débris and can not receive the whole volume of water, it is backed up Mill Creek. and the low country south of the railroad at Lloyd is inundated. It is quite apparent that owing to the character of the underlying limestone much of the drainage of the county is underground.

In 1824 the counties of Walton, Leon, Alachua, and Nassau were established, and in 1827 Jefferson County was cut off from Leon County. Monticello, which up to that time had been an Indian town and trading post, was surveyed for the county seat early in 1828.

The early settlers came from Virginia and South Carolina and located in the northern half of the county. In 1900, according to the United States census, the total population of the county was 16,195, the majority being of the negro race. The southern part of the county below the Tallahassee Southeastern Railroad is sparsely settled. Monticello, the county seat, is the principal town, with a population of about 1,100. It is situated in the north-central part of the county on the Atlantic Coast Line and Seaboard Air Line railroads. It is 25 miles south of Thomasville, Ga., 31 miles east of Tallahassee, 32 miles west of Madison, and 142 miles west of Jacksonville. The towns of next importance are Aucilla and Lloyd, on the Seaboard Air Line, and Wacissa, on the Tallahassee Southeastern Railroad. Lamont and Waukeenah are prosperous inland villages.

The county is well supplied with transportation facilities. The Seaboard Air Line crosses the county from east to west, connecting Jacksonville, Tallahassee, and Pensacola. A branch of this road connects Monticello with the main line at Drifton, 4 miles to the south. The Atlantic Coast Line connects Monticello with Thomasville, Ga., and other points north. The Tallahassee Southeastern Railroad crosses the county 10 to 15 miles south of the Seaboard Air Line. The West Coast Railway, connecting Greenville with Quitman, Ga., passes near the northeastern corner of the county and offers an outlet for that section. A railroad connects Delph with the St. Mark's branch of the Seaboard Air Line in Leon County. This line is being extended northward through the western part of Jefferson County to Thomasville, Ga. Another road in process of construction

crosses the southern townships, and when completed will connect St. Marks on the west with Perry and points east. The county roads could be considerably improved with materials at hand and doubtless will be as settlement progresses. The sandy clay subsoils form an excellent surfacing material.

Monticello is the principal market for cotton and other farm crops produced in the north-central part of the country. In the extreme northern part much of the cotton is sold at Thomasville and Metcalf, Ga., while Quitman, Ga., is the market for the northeast corner.

CLIMATE.

The climate of Jefferson County is generally mild and balmy. Many northern tourists spend the winter months within its borders. During the coldest months of December, January, and February the temperature occasionally falls to 20° F., and frosts are not uncommon. In July and August, the hottest months, the temperature rarely exceeds 90° F. in the shade and 80° F. is the average. The nights are usually cool and often attended by a delightful breeze from the Gulf. Between 50 and 60 inches of rain falls annually, which is generally quite evenly distributed throughout the year. Short droughts may, however, occur during the growing season. The heaviest precipitation occurs in July and August, the normal at Monticello for these months being 7.88 and 7.10 inches, respectively.

The following table, compiled from the records of the Weather Bureau stations at Waukeenah, within the county, and at Tallahassee, in the adjoining county of Leon on the west, shows the normal monthly and annual temperature and precipitation:

Normal monthly and annual temperature and precipitation.

Month.	Tallahassee.		Waukeenah.*		Month.	Tallahassee.		Waukeenah.*	
	Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.		Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.
	<i>°F.</i>	<i>Inches.</i>	<i>°F.</i>	<i>Inches.</i>		<i>°F.</i>	<i>Inches.</i>	<i>°F.</i>	<i>Inches.</i>
January.....	51.5	3.51	52.2	1.52	August.....	79.1	7.44	82.4	4.25
February.....	54.6	5.73	49.0	4.70	September...	76.7	4.64	77.1	14.88
March.....	59.2	5.59	61.7	4.20	October.....	67.8	3.42	69.0	5.00
April.....	66.9	1.99	66.6	1.10	November.....	58.9	2.58	-----	-----
May.....	74.5	3.48	78.2	2.90	December.....	52.8	4.10	53.4	7.35
June.....	78.8	6.36	82.2	10.97	Year.....	66.8	57.07	-----	-----
July.....	80.4	8.23	83.4	2.08					

* The temperature and precipitation for Waukeenah are for the year 1902 without departures from the normal.

The following table gives the dates of the first and last killing frosts recorded at Tallahassee for a period of seven years, 1896 to 1902, inclusive.

Dates of first and last killing frosts.

Year.	Tallahassee.		Year.	Tallahassee.	
	Last in spring.	First in fall.		Last in spring.	First in fall.
1896.....	Feb. 21	.....	1900.....	Feb. 25	None.
1897.....	Jan. 30	Dec. 28	1901.....	Mar. 17	Dec. 15
1898.....	Feb. 22	Nov. 27	1902.....	Feb. 18	Dec. 27
1900.....	Mar. 8	Nov. 4	Average.....	Feb. 21	Dec. 8

AGRICULTURE.

Jefferson County represents a well-established agricultural section of the State, farming having been carried on here for about eighty years. The first settlers located in the northern part of the county, many acquiring large tracts of land. Slave labor was plentiful and general farming, with cotton the chief and money crop, was soon established upon an extensive scale. Considerable attention was also paid to stock raising. Corn, oats, and wheat were among the crops grown, but since 1880 the acreage of small grains has greatly decreased and wheat is no longer grown at all.

The agricultural practices to-day are along practically the same lines as those of the early farmer. The tendency is toward an extensive rather than an intensive system. It has been demonstrated on a few farms that by systematic and thorough cultivation one-third of the land now devoted to cotton can be made to produce as much cotton as the present acreage. The other two-thirds is capable of and should be used in the production of the forage, fruits, and vegetables required for home use, with perhaps a surplus to sell.

Continuous cultivation to a clean-culture crop without adding to the soil the humus necessary to keep it in good condition has caused a decline in the productiveness of some of the older plantations. In former times when the land became "exhausted" it was allowed to "lie out" and soon became a thicket of old field pine, brush, and briers. When a field was thus abandoned it was customary to clear a new piece of ground to take its place. This was done either by "deadening" the larger trees by girdling, plowing the ground, and planting in cotton, or by deadening the timber and later burning it. A change to more modern methods of farming would bring the land of lowered productiveness again to its original state. Commercial fertilizers were experimented with as early as 1860 and began to be used sparingly in 1870. In 1900 about \$9,000 was expended for fertilizers in the entire county.

Cotton, corn, sugar cane, and sweet potatoes are the principal crops grown at present, while oats, hay, sorghum, peanuts, and pecans are grown to a less extent. Corn has the largest acreage, and is grown

solely for feeding on the farm. Cotton is to-day, as it always has been, the money crop of the county. It is grown often to the exclusion of the subsistence crops, many farmers being compelled to buy corn, oats, hay, and even meat, all of which could be profitably grown in conjunction with cotton, and at the same time a suitable rotation of crops arranged and the fertility of the soil maintained. The long-staple (Sea Island) cotton produces well, and there has been a steady increase in the acreage given this variety within the last few years. Long-staple cotton commands a higher price than the short staple, and requires more careful and systematic cultivation. Negro tenants prefer the short-staple cotton on account of ease of cultivation and larger yields; hence the greater part of the long-staple cotton now grown is produced by white farmers. In 1900 the acreage of Sea Island cotton was 1,176 acres.

Both the Japanese and red sugar cane are grown quite extensively, and produce a sirup of excellent quality and flavor, most of which is consumed by the producers. One man manufactures table sirup on a commercial scale and supplies distant trade. Large areas of soil are well suited to the growing of sugar cane and the excellent quality of the sirup should encourage the growers to establish this industry upon a money-making basis.

For the successful growing of winter vegetables and all kinds of berries the light sandy soils and the climate of the county are well adapted. All varieties of vegetables, tomatoes, cabbage, early corn, cantaloupes, and watermelons produce abundantly, and there is unlimited opportunity for the development of the trucking industry. Melons are grown both for shipping and for the seed. At the present time there is not enough garden produce grown to supply the Monticello market. Truck growing would combine well with general farming, for the principal truck crops would be off the land in time to permit the growing of a second or perhaps a third crop within the year.

One drawback at present to the trucking industry is the difficulty of developing it to a point where suitable facilities and low rates can be afforded by the transportation companies. There is always this period in the life of any new industry, and the hearty cooperation of the railroads and prospective shippers can easily solve the problem. There can be no doubt that the trucking industry, when systematically developed, will be the source of a large income to the county.

Many orchards of Le Conte pear are seen, and fair crops are sometimes secured. With care such as is given the orchards where fruit growing is made a success the returns could be greatly increased. The Kieffer pear is also grown, and being less susceptible to blight is a much more certain bearer. Figs produce abundantly and some are sold as preserves. Peaches do well and from one small orchard of a

few trees just south of Monticello over \$40 worth of fruit was sold last season. It is believed that commercial peach growing might prove remunerative.

The Norfolk and Orangeburg soils of Jefferson County are identical with the soil types that occur in Gadsden and Leon counties. In these counties, which lie to the west of Jefferson County, shade-grown tobacco has been successfully produced for a number of years, the industry being particularly well established in Gadsden County. This year (1907) marks the beginning of the growing of Sumatra wrapper-leaf tobacco under shade in Jefferson County. Tobacco for home consumption has been grown heretofore by many farmers. Two shades, one covering 10 acres and the other about 3 acres, were erected this year, and an increased acreage will be shaded next season.

The production of pecan nuts is very profitable and large orchards of grafted and budded trees are being set out. The soils of the area are well suited to the growth of the pecan and the outlook for commercial pecan growing upon a large scale is very promising. The growing of pecans and of tobacco will be more fully discussed under a succeeding head.

Dairying permits an ideal type of diversified farming. It distributes the income from the farm quite evenly throughout the year and at the same time builds up the soil. The opportunities for developing the dairy industry in Jefferson County are exceptionally good. There is a good demand for high-class dairy products in the home markets and in the larger towns and cities outside the county. A great variety of forage crops can be cheaply produced and pasturage is available for the greater part of the year. There is one dairy in the county near Monticello, where from 30 to 40 head of Guernsey and Jersey milch cows are kept. Besides supplying Monticello with milk, from 4,000 to 5,000 pounds of butter are made each year and sold at an average price of 40 cents a pound.

Seeing the great need of introducing new crops, not only for his cattle, but also for building up a profitable system of crop rotation, this one man has attempted to grow several crops new to the county. Alfalfa, vetch, rape, ruta-bagas, and wheat have proved valuable additions to the general farm crops, and their successful production should be an incentive to others, whether engaged in the dairy business or not, to adopt them. Lespedeza and rye for pasture might also be added. On account of its feeding value and the heavy yields produced, alfalfa is without doubt the most valuable hay crop that can be grown, and is in addition a splendid soil renovator. Alfalfa requires thorough preparation of the soil and careful attention, and does best on inoculated soils. From five to seven cuttings are made each year. Vetch grown with some of the winter cereals—oats, wheat, or rye—makes a very good quality of forage. Sorghum,

cowpeas, and crab grass form the hay crops. Oats and wheat cut while green and cured as hay make an excellent feed and should receive more attention.

For the dairy the silo is indispensable. It is used at the one dairy mentioned and furnishes ensilage from October until May 1. Cowpeas planted at the first working of corn and siloed with the corn make good silage. Thrifty patches of Bermuda grass and Johnson grass were noticed and it is believed that these could be successfully propagated.

When the larger plantations are divided into smaller tracts of land and settled upon the need of intensive cultivation and rotation of crops will manifest itself and doubtless will be heeded. At present the rotation, if such it may be called, does not take into consideration the betterment of the soil. The common practice is to grow cotton from two to three years, followed by corn from one to three years. This is the simplest system of rotation and best suits the man who does not wish to keep live stock. By using some winter-growing legume, such as bur clover or vetch, for the intermediate soil-renewing crop, the producing capacity of the soil may be greatly increased. This system affords an abundance of excellent winter pasturage for the farm animals, but rotations involving the use of a greater diversity of crops are more satisfactory. Cotton under such a system is made more a surplus crop, and the income of the farm instead of being confined to one part is distributed over a greater part of the year. A four-year rotation used by one farmer, and earnestly recommended, consists of cotton the first year, corn and cowpeas the second year, oats the third year, followed by cotton the fourth year.

Quite a few farmers are devoting their attention to the raising of hogs and cattle and to crops other than cotton. There is always a strong demand for pork and it can be produced very cheaply. Every farmer should produce enough for home consumption and a little for sale. Vetch, rape, and winter cereals will produce an abundance of winter grazing. One acre of alfalfa will furnish grazing for 15 or 20 head of hogs from April to September. Besides supplying the local markets one dealer ships to Jacksonville in car-load lots. He also ships dressed pork.

In planting, cotton is usually given the preference of the soils, corn and other crops being planted on whatever area may remain for cultivation. The Orangeburg fine sandy loam is considered the best cotton soil and the Norfolk soils are better for corn, oats, and hay. Cotton is the crop the negro best understands producing, and by him, under the tenant system, the most of the crop is grown.

The common method of rental is to rent "one-mule farms," about 40 acres, for which 700 to 1,000 pounds of lint cotton is paid. An

"ox farm" consists of about 20 to 25 acres. It is generally conceded that 40 acres is too much land to be properly worked by one mule, and it is believed better results would be attained on 30 acres.

A very small percentage of the farms of the county are operated by the owners. Many land owners live in Monticello and in Quitman, Ga. They furnish the tenant with provisions for the year or arrange with a merchant to issue a stipulated amount of merchandise. A cash rental is sometimes paid for land, the rate ranging from \$1.50 an acre for general farming purposes to \$5 or \$7 an acre for nursery stock near Monticello.

According to the census of 1900 the value of farm lands and improvements, exclusive of buildings, was \$712,185, but at the time of the survey (1907), land values had increased considerably. The value of the farm buildings was \$209,495, and the total acres in farms was 114,142. The average size of the farms was given as 77.1 acres, but this is misleading, as the census counted each tenancy as a separate farm. A few farms are small, but many tracts embrace 1,000 acres or more, and some plantations include as much as from 5,000 to 12,000 acres.

Within the last few years the price of land has steadily advanced. This is due mainly to the increase in the price of timber and turpentine, and recently in part to the introduction of special agricultural industries, the growing of tobacco and pecans. Lands in the vicinity of Monticello sell at from \$25 to \$50 an acre, the latter price being paid for desirable land for tobacco, pecans, and nursery stock. Unimproved land in the northern part of the county may be had for \$6 to \$15 an acre. In the southern part cleared land does not sell for over \$10 an acre, while well-timbered land may bring as much as \$25 an acre. The greater part of the flatwoods region has been purchased by lumber companies for the timber and turpentine. The abundance of cypress in the swamps of the county furnishes splendid material for barrel staves, cross-ties, shingles, and fence posts.

Much of the county has recently been fenced with well-built, substantial barb-wire and woven-wire fences, and the old pine-rail fences which have served their purpose are being rapidly replaced. It costs about \$80 to build 1 mile of rail fence and about \$125 for the same length of the best patterns of woven-wire fencing.

In Jefferson County negro labor is employed almost universally. For several generations the labor has been trained to grow cotton and to look upon this crop as the only source of income. The present laborers are unfamiliar with the use of improved machinery, and, of course, unskilled in the working of new crops. Any radical changes, therefore, in the type of farming must be made gradually, it being necessary to train the labor along the new lines. Many are employed in tobacco fields of Gadsden and Leon counties, where good wages are

paid and this shows what can be done with such help in a crop requiring intensive cultivation.

The soils of Jefferson County are susceptible of improvement and attention should be paid to their permanent upbuilding. The most important requisites for accomplishing this are greater diversification and rotation of crops, the growing of legumes, better and more thorough tillage, the keeping of more live stock, and the more extended use of improved machinery.

SPECIAL INDUSTRIES.

TOBACCO.

Recently very general interest has been manifested in the growing of Sumatra wrapper-leaf tobacco under shade. The lighter phases of the Norfolk fine sandy loam and Orangeburg fine sandy loam are particularly adapted to the production of shade-grown tobacco.

In the growing of tobacco the seed bed should be given special attention, as it is of prime importance. A good stand of strong, sturdy plants is essential to a successful tobacco crop. The northern box-bed used in Connecticut is rapidly supplanting the old method of selecting a damp place in woodland near a stream or swamp and burning it over. Seed beds should be planted from February 15 to March 15, thereby securing plants suitable for transplanting from April 15 to May 20. Tobacco requires a thoroughly prepared soil and frequent and systematic cultivation. The ground should be plowed deep in the fall then reseeded in the spring and subsoiled to a depth of 15 inches. From March 15 to April 1 stable manure, 20 tons to the acre, should be plowed under, after which lime, 400 pounds to the acre, should be spread broadcast and harrowed in. Two weeks before transplanting from the seed bed to the shaded area the ground should be laid off in beds 4 feet apart and the fertilizer applied.

Tobacco, unlike most other crops, is fertilized for quality and foliage and care should always be exercised in the selection of a desirable fertilizer. Chlorine should always be avoided. The fertilizer in general use and up to the present time the most satisfactory, consists of 2,000 pounds of cotton-seed meal, 400 pounds of steamed bone meal, and 300 pounds of carbonate of potash, all thoroughly mixed and distributed in the furrow. The shovel plow is then used to mix thoroughly the fertilizer with the soil, after which the ground is listed from each side, forming a bed which is left until time for transplanting. The bed is then reopened and rebudded and the soil is thus put in excellent condition to receive the plants, which are set at intervals of 14 inches. From this time on the plants should receive frequent cultivation by means of shallow plowing and hand hoeing.

To erect a shade over 1 acre of ground costs, including material and labor, about \$250. It is estimated that under favorable conditions the first year's crop will pay for the shade. For 1 acre of shade about 170 posts are required; these should be 11 feet long, 9 feet clear, and set 12 by 20 feet apart. Extra posts are placed 2 feet apart on the outside row on each end to carry the wire which supports the slats. About 1,000 pounds of No. 8 wire is used as a support upon which to weave the slats. It takes about 40,000 slats, which are woven on the wires at such an interval as to give one-third shade and two-thirds sun. Slats cost from \$1.50 to \$3 per thousand, depending upon the kind and quality used. Some growers prefer the "veneered" slat, while others claim that the sawed slat is more durable. It requires about 60 pounds of No. 22 galvanized wire to weave 1 acre of slats, which should run north and south in order to secure an even distribution of shade upon the tobacco. The entire structure is braced on all four sides by guy wires running from the top of the outside posts and securely fastened to blocks of wood which are buried in the ground. The life of a shade is about five years.^a

Harvesting the crop begins about sixty days after transplanting and usually covers a period of about four weeks. A fully matured tobacco plant should produce from 20 to 26 leaves. After the leaves are primed, i. e., pulled from the stalk, 36 to 40 of them are strung on a stick and placed in curing barns to dry in tiers 2 feet apart. It requires from three to four weeks for tobacco to cure. The average yield per acre is about 1,000 pounds, and the price ranges from 55 to 75 cents per pound in the bundle, according to the quality of the leaf.

In a tobacco barn 140 feet long, 40 feet wide, and 16 feet to plate, 5 acres of tobacco can be cured. The cost of a barn of these dimensions is about \$1,000. It should be located in the open in order to insure good circulation of air and an abundance of sunshine.

The Orangeburg fine sandy loam is adapted to the production of Cuban filler. This tobacco is grown in the open and the methods of fertilizing and cultivation are practically the same as those used in the production of shade tobacco. In harvesting this type of tobacco the entire stalk is cut and hung in the barn to cure. The average yield is about 600 pounds per acre and the price ranges from 20 to 25 cents per pound, depending upon the quality of the leaf.^b

^a Prospective growers of tobacco under shade will find much valuable information in Bulletin No. 20. Growing Sumatra Tobacco under Shade in the Connecticut Valley. Bureau of Soils, U. S. Department of Agriculture, 1902.

^b For a detailed account of experiments in growing this kind of tobacco on Orangeburg soils in Alabama, see Bulletin No. 37, Bureau of Soils, U. S. Department Agriculture, 1906.

PECAN INDUSTRY.

The pecan industry, though still in an early stage of development, gives promise of great success. Seedlings here and there in door-yards give evidence of the productiveness of the pecan tree in this region. The soils and existing conditions as found in Jefferson County are particularly adapted to the pecan nut and especially to the growing of nursery stock. In a great many sections of the pecan producing belt, which is about 200 miles wide, two years are required to produce a seedling large enough to graft. In the Jefferson County area, however, upon the Norfolk fine sandy loam, a sturdy growth from 10 to 20 inches high is produced in one year. Upon the Orange-burg fine sandy loam a good growth is secured, but more time is required. In Monticello and vicinity there are about 3,000 bearing pecan trees, mostly seedlings. Recently numerous orchards of grafted stock have been set out and the acreage is rapidly increasing.

Pecan trees are usually set about 47 feet apart or from 15 to 17 to the acre. Trees begin to bear the sixth or seventh year, and a tree 7 years old should be 20 feet high, with a spread of 10 feet.

Trees should be well cared for to insure best results. Each year 1 pound of complete fertilizer should be applied to the roots of each tree, and besides a liberal dressing of barnyard manure should be given the land in winter. In one instance a seedling tree 22 years old produced 638 pounds of nuts in one season and netted the owner \$79. Others have produced proportionately as well. The favorite varieties of nuts are the Schley, Pabst, Stuart, Frotscher, and Van Deman. Monticello is at present considered the largest pecan market in the United States. Six companies are actively engaged in growing nursery stock and nuts and are doing a thriving business. Acres of nuts are planted each year, the trees grafted, and placed on the market the following year. The wholesale price for nuts ranges from 10 cents per pound upward, while nursery stock sells according to age. The industry is a very profitable one when once established, and excellent opportunities are offered in Jefferson County for its development on an extensive scale.

SOILS.

The two superficial geological formations from which all the soils of the area have been derived are the Lafayette and Columbia. The former covers the central and northern parts of the county; the latter extends from the southern edge of the uplands to the coast, and consists entirely of marine sands of recent deposition.

The Lafayette formation comprises two quite distinct members. The upper one—excepting its superficial weathered portion—is a homogeneous red sandy clay. It grades downward into material of

the same general lithological character, but this lower part is obscurely stratified, includes considerable loose sand, and lacks the distinctive red color of the overlying stratum. The multicolored sands and sandy clays so frequently shown in the roadside ditches mark the transition from the upper members to the lighter-colored basal strata.

The upper stratum is not generally more than 10 or 15 feet in thickness, frequently much less, but it follows the topography, extending from the highest divides to the borders of the larger valleys and swamps. It thus mantles the subjacent portions of the Lafayette formation, which, if they affect the soil in any measure, form only the deep subsoil. It is highly probable that the compact red sandy clay represents the depth to which weathering—chiefly chemical changes affecting the iron—has penetrated the Lafayette material. But the present soils owe their origin and distinctive features to changes within or upon this red stratum. More than one-half of its mass is formed of the finer grades of quartz sand and about one-third consists of clay. There is a marked absence of silt and the coarser grades of sand. Very little of this material is readily soluble or easily oxidized. Its weathering consists for the most part of a mechanical dissolution of the sand and clay, with an accompanying change in color due principally to the different forms or combinations of the included iron salts, of which the content is relatively high.

Erosion and solution are the chief factors in the process of soil formation. In this case erosion is the more effective in producing changes in the texture. It takes place not only at the surface, but through or among the sand grains as they are loosened from the clay matrix. Thus the finest particles are in process of removal, the rate depending upon the rainfall and local differences in topography, texture of the material, and character of the vegetal covering.

In some phases surface erosion has removed the loosened materials about as fast as the processes of weathering have released them. This is apparent on some of the steepest hillsides, where the red sandy clay forms the soil—a heavy phase of the Orangeburg fine sandy loam. Where the surface wash has been less vigorous and other forces of weathering—especially those causing change in color—have not penetrated to a depth of more than 2 feet the usual phase of the Orangeburg fine sandy loam has resulted.

Where erosion has been the most effective agent the finest particles have been removed or carried to a depth which will average about 3 feet over much of the uplands, and leaching and other changes affecting the soil color have been comparatively vigorous. The Norfolk sand of the uplands has originated in this manner. This same type, as usually developed upon the lower slopes and in the valleys, contains much transported material derived from the adjacent hill-

sides. But this change in location has not resulted in much assortment of this material, as the average distance has been too short. Hence the texture of this sand is about the same as that of the uplands where the sand is in situ. A few phases were observed where the greater depth of the Norfolk sand and its topography suggested drift by wind. Such a result might have followed the destruction of the vegetal covering at some period, or might have occurred near old beach lines.

The separation of these soils into sands and fine sandy loams expresses approximately the extent, or more correctly the depth to which erosion has affected the superficial portions of the Lafayette formation. This applies to both the Orangeburg and Norfolk types, but especially the latter, which represent the greater differentiation from the original material. The same may be said of the color changes, which are the basis for the separation of the Orangeburg and Norfolk series. No sharp lines can anywhere be seen between these series or their several types.

The soils of the flatwoods owe their distinctive features to causes quite different from those just outlined. The surface formation is a fine, siliceous sea sand. This sand overlies a nearly impervious clay derived from phosphatic limestone.^a These three strata—the sand, clay, and limestone—extend from the coast to the escarpment which separates the uplands from the flatwoods. The sand presents local variations in thickness, and the clay is wanting in a few places, but the limestone underlies all this low country. It is usually found at less than 10 feet below the surface. Exposures occur along all the streams and in the numerous “sinks,” but the rock has directly affected the soil in only a few localities.

A profile of the flatwoods region taken in any direction would be a slightly wavy or broadly undulating line; if the average level of the water table were represented by a nearly horizontal line the latter would cut the former at many places. The areas of drained and undrained land would not only be graphically shown, but the distinctive feature of each soil would be suggested. The organic content is a very important as well as conspicuous element in each type. The amount and form in which it appears is directly dependent upon drainage.

The Norfolk soils would be represented by the highest parts of the profile. They lie well above the plane of permanent saturation and the organic matter is in the form of humus. The swamp and marsh would coincide with the lowest portion of the cross section. They contain a large amount of vegetal remains, mostly in the form of

^a A chemical analysis of a sample of this rock taken about 10 feet below the surface of the ground gave 0.1 of 1 per cent phosphoric acid. A similar quantity was found in the clay overlying the rock.

muck mixed with fine sand. The intermediate levels would represent the Portsmouth and Leon soils. In each of these the fluctuations of the water level have produced some changes not easily explained. Where complete saturation and free aeration frequently alternate, as in the Portsmouth fine sand, the organic matter is mostly muck and there has been an accumulation of iron at one particular level in the subsoil. The Leon fine sand usually contains but little vegetable material in any form, although in many instances conditions seem favorable for its accumulation.

The classes of soils in this area are limited to sands and sandy loams. All are highly siliceous, for the sand presents little or no variety in its composition. Such differences in agricultural value as the types in one physiographic province present when compared with those of the other are more closely associated with topography and drainage than with textural and mineralogical distinctions.

The table following gives the names and areas of the several soils found in Jefferson County. The distribution of the soils is shown on the accompanying soil map.

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Norfolk sand.....	105,836	28.8	Portsmouth fine sandy loam.....	6,016	1.6
Norfolk fine sandy loam....	65,472	17.4	Marsh.....	5,504	1.5
Portsmouth fine sand.....	57,964	15.5	Orangeburg sand.....	4,800	1.3
Swamp.....	54,400	14.5	Gadsden sand.....	2,406	.7
Orangeburg fine sandy loam.....	29,568	7.9	Norfolk very fine sandy loam.....	766	.2
Norfolk fine sand.....	17,344	4.6	Gadsden sandy loam.....	640	.2
Meadow.....	14,080	3.8	Sandhill.....	128	.0
Leon fine sand.....	9,536	2.5	Total.....	374,592	

NORFOLK SAND.

The surface soil of the Norfolk sand consists of gray, light-brown, or yellow sand, with a depth of 10 to 24 inches. The sand is medium to fine in texture and contains sufficient organic matter to make it loamy. To the north of Lloyd the sand is somewhat coarser and is looser in structure. In a few other areas the sand is comparatively incoherent, but these areas are small in extent and the soil consists for the most part of a loamy sand.

The subsoil consists of a yellowish or light-gray sand of texture similar to the soil, though with a more open structure. At a depth of 28 inches the sand may become sticky or give way to a sandy clay. This condition exists usually where the Norfolk sand is closely associated with the sandy loam types. Where the clay occurs at less than 28 inches below the surface the soil has been mapped as Norfolk fine sandy loam.

The Norfolk sand and the Norfolk fine sandy loam are, therefore, closely associated and the one grades imperceptibly into the other. The different tints of the surface soil are due to the varying quantities of organic matter. Where not tilled the soil has a dark color and is loamy in character, but where farmed continuously the dark color soon disappears and the soil becomes light gray or whitish in color.

The Norfolk sand covers about 28 per cent of the uplands and is the most widely distributed of the soils. The surface features of the Norfolk sand vary from rolling to comparatively level country. It occupies hills, ridges, and valleys, and with the exception of a few fairly flat areas is well drained. The comparatively porous texture causes the soil to dry out in early spring and the relatively high content of organic matter and high percentage of fine material make it a warm soil.

The Norfolk sand is derived for the most part from the Lafayette formation. Some areas are reworked material washed down from the hills into the depressions and valleys. Some of the low-lying areas probably owe their origin to the Columbia formation. This is particularly true of the extensive area which extends north and south of Aucilla and west to Drifton. This area is usually quite level and the drainage is poorly defined. Small cypress and gum ponds, many of which are too insignificant to be shown upon the map, are numerous. This impounded condition represents immature drainage, and little of this soil in such places is at present under cultivation.

The native growth consists of longleaf and shortleaf pine, oak, hickory, and wire grass, and on the low-lying areas magnolia, bay, gum, ferns, palmetto, briers, and gallberry bushes.

The Norfolk sand is preeminently a trucking soil. Peas, beans, radishes, lettuce, cantaloupes, watermelons, strawberries, etc., do exceptionally well and their production should prove remunerative. Any crop requiring a light, loamy, sandy soil would do well upon the Norfolk sand. Cotton, corn, and cowpeas are extensively grown and fairly good yields are secured. Upon the well-cared-for fields corn yields 25 bushels, cotton about one-third bale, and oats from 25 to 40 bushels per acre. Long-staple cotton produces good yields when properly cultivated and should be more extensively grown. Alfalfa also does well in some sections. In favorable seasons, and probably in all seasons where irrigation is provided, the Sumatra wrapper leaf tobacco would be a profitable crop. In order to retain the organic matter in the soil and its loamy texture, the growing of leguminous crops should be practiced. The natural growth of weeds and broomsedge should not be burned, but should be plowed under. Deeper plowing should also be practiced.

The price asked for Norfolk sand is slightly less than for the Norfolk fine sandy loam, or the Orangeburg fine sandy loam.

The following table gives the average results of the mechanical analyses of samples of this soil:

Mechanical analyses of Norfolk sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16496, 16500-----	Soil-----	0.9	10.1	14.5	51.1	14.2	5.7	3.4
16497, 16501-----	Subsoil-----	1.0	9.6	13.1	52.9	14.7	5.5	3.2

NORFOLK FINE SANDY LOAM.

The Norfolk fine sandy loam consists of a gray or light-brown loamy sand or sandy loam varying in depth from 8 to 24 inches, with an average depth of about 18 inches. The sand consists of medium and fine grades. The subsoil is a yellow or yellowish-red sandy clay, sometimes grading into mottled gray, red, and yellow at a depth of 3 feet or more.

The sandy character of the soil makes it easy to cultivate and the open structure permits of free movement of soil moisture and makes it a warm early soil.

The largest continuous area of this soil passes northward through Monticello and continues unbroken to the State line. A large area also lies northwest of Nash and other areas of considerable extent are found distributed through the uplands.

The Norfolk fine sandy loam occupies gently undulating to rolling areas, most of which are well suited for cultivation. The natural drainage is good, owing to the topography and light texture, and artificial drainage is necessary only in draws and depressions.

Where this soil occupies nearly level areas there is slightly more organic matter present in the soil, and this imparts to it a more loamy texture.

The Norfolk fine sandy loam is derived from the Lafayette formation which overlies the northern two-thirds of the county. Some of the material composing the surface soil shows evidence of having been slightly reworked. The soil is adapted to the growing of cotton, corn, sweet potatoes, peanuts, alfalfa, truck, pecans, and tobacco. Sea-Island cotton grows well and produces an average yield of 700 pounds of seed cotton per acre when fertilized. With the same applications of fertilizers from 20 to 45 bushels of corn are produced.

The Norfolk fine sandy loam is well adapted to sugar cane and the flavor and color of the sirup are better than upon the soils with red subsoils. Velvet beans, peanuts, cowpeas, and beggar-weed are forage crops which grow readily and add greatly to the productiveness of the soil.

Alfalfa is being successfully grown upon this soil at the dairy farm just south of Monticello. After thoroughly preparing the ground and adding 400 pounds of soil from an alfalfa field and 200 pounds of bone meal, 25 pounds of alfalfa seed to the acre was drilled in rows 20 inches apart. This was planted in November. During the winter the crop was cultivated and April 20, when the alfalfa was 22 inches high, the first cutting was made. The second cutting was made May 18, the third cutting June 16, the fourth cutting July 16, and the fifth cutting August 20. As many as 7 cuttings a year may be made, and no better hay crop can be grown. Wheat sown in December and cut about the first of May produced over 18 bushels per acre. Oats sown broadcast, from 2 to 3 bushels per acre, in October, and cut when in the milk stage and cured as hay form a valuable feed. Care should be taken to secure rust-proof varieties of oats and wheat.

The Norfolk fine sandy loam is the ideal soil for growing Sumatra wrapper-leaf tobacco under shade. For best results the surface soil should be from 10 to 18 inches deep and underlain by a bright yellow sandy clay. If properly cared for tobacco grown under shade upon this phase of the Norfolk fine sandy loam will find a ready market at a profitable price. The leaf will seldom have any defect, but will be of desirable color, excellent quality, and satisfactory burn. It is upon this type of soil that the first shade tobacco in Jefferson County was produced and the success of the crop has greatly increased the value of this soil. The pecan tree grows more rapidly upon this soil than upon the Orangeburg fine sandy loam. As upon the other soils of the county deeper plowing, more extensive crop rotation, and the growing of more leguminous crops are recommended.

The price of the Norfolk fine sandy loam varies greatly with the location. Near Monticello it is sought after for growing tobacco and pecans and sells for from \$25 to \$50 an acre. More remote from railroads it may be bought for \$10 to \$25 an acre.

The original timber growth consists of pine, oak, and hickory, but large areas have been cleared.

The following table gives the average results of mechanical analyses of samples of this soil:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16508, 16510	Soil	0.3	5.2	8.9	48.2	20.6	8.5	8.3
16509, 16511	Subsoil	.2	4.1	6.4	38.9	15.0	7.6	29.9

ORANGEBURG FINE SANDY LOAM.

The soil of the Orangeburg fine sandy loam consists of gray, brown, or reddish-brown medium to fine sandy loam, 8 to 15 inches deep. The subsoil is a very red clay containing from 40 to 60 per cent of medium to fine grades of sand with very little silt. Underlying the red sandy clay, which usually ranges in depth from 5 to 15 feet, exposures show mottled clay and cross-bedded sands.

Iron concretions are present in both soil and subsoil and occasionally ferruginous pebbles several inches in diameter are found. Where the surface is comparatively level the soil is usually a loamy sand resting upon a red clay foundation, the line of contact being very sharp.

The Orangeburg fine sandy loam occurs throughout the northern two-thirds of the county and is typically developed in the northwest corner. This area represents a continuation eastward of the extensive area mapped in Leon County. Other areas varying in size occur, usually associated with the Norfolk fine sandy loam.

The topography for the most part is rolling, although some small areas are only undulating. The area bordering Lake Miccosukee on the north occupies the highest elevation in the county, but nowhere are the slopes precipitous. On the steeper slopes, however, much of the surface soil has been removed, exposing the underlying red clay. The natural excellent drainage is due both to its topographic position and the character of both soil and subsoil.

The Orangeburg fine sandy loam is the weathered product of sedimentary material of the Lafayette formation. This soil is the heaviest and strongest of the county and the greater part of it is under cultivation. It is well adapted to general farm crops, but it is considered best for cotton. The soil is very productive, and as the impervious subsoil prevents leaching to any marked degree, fertilizers are well retained. The average farmer realizes an average yield of one-third bale of cotton and from 8 to 15 bushels of corn per acre without fertilizer. The oat crop grown for hay produces well. The soil is especially well adapted to the production of Cuban filler tobacco. The red subsoil produces a heavy, dark-colored leaf of excellent quality. The filler leaf is grown in the open with yields ranging from 600 to 800 pounds per acre.

The pecan tree thrives well on this soil, making a strong, sturdy growth. At present the methods of cultivation practiced upon the Orangeburg fine sandy loam are often inadequate to obtain the best results. By more careful and systematic methods of cultivation, the growing of legumes, and the systematic rotation of crops, the productiveness could be very greatly increased. Plowing should be deeper, a depth of at least 10 inches being desirable. In this work a

disk plow which can be drawn by 3 mules can be used to advantage and the soil then harrowed in order to secure a good seed bed.

A few farmers practice deep plowing and recommend it, and by careful selection of seed 40 bushels of corn per acre can be produced. The glassy flint variety is less affected by the weevil. On account of the lasting effects of fertilizers farmers feel that they can well afford to use them on the Orangeburg fine sandy loam.

No definite system of crop rotation is practiced. As good yields of cotton are secured each year most of the area under cultivation is devoted to this crop. Improved land can be had for from \$10 to \$20 an acre.

The following table gives the average results of mechanical analyses of samples of this soil:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
16521, 16523 -----	Soil-----	0.6	12.2	13.3	38.2	11.8	11.9	9.4
16522, 16524 -----	Subsoil----	.6	8.9	9.0	34.1	11.9	7.9	23.1

ORANGEBURG SAND.

The soil of the Orangeburg sand, to a depth of 6 inches, consists of a medium reddish-brown loamy sand. It usually contains enough silt or clay to cohere if a moist sample is pressed in the hand. The organic content is generally low, so that the loamy quality which the soil possesses is due to the texture of the mineral constituents. In old fields the surface color when dry is a light brownish gray, and the soil is quite loose to the plow line. Below this depth it is much heavier in texture and darker in color.

The subsoil is a dark-red sticky sand. In some places it is a dull reddish-yellow color, becoming a more pronounced red with increase of depth. From 25 to 30 inches below the surface it changes in texture to a sandy loam or sandy clay, and at a depth of about 3 feet this material usually becomes quite stiff, closely resembling the subsoil of the Orangeburg fine sandy loam.

This soil is found in the uplands, usually associated with the Orangeburg fine sandy loam. It is typically developed in many of the shallow depressions or small basins which are of common occurrence upon some of the broad divides. In such locations it evidently represents accumulations of sand which have not suffered so much weathering as the Norfolk sand. But in general its development is not confined to any particular topographic position, nor is it connected with any noticeable local difference in color or texture of the Lafayette material. In some instances it occupies slopes or undu-

lating areas, while in depressions near by, in which conditions apparently favor an accumulation of loose sand, the subsoil is often heavy. It is locally developed in the larger bodies of the Orangeburg fine sandy loam, but usually in areas too small and ill defined to map.

Most of this soil is under cultivation, being planted each year to the staple crops, corn and cotton. The average yields are not quite as high as those obtained under similar conditions upon the Orangeburg fine sandy loam.

Like the other light sandy soils of the county the Orangeburg sand is deficient in humus, and cultural methods should be directed toward the addition of organic matter and the conservation of moisture.

While this soil is somewhat inferior to the Orangeburg fine sandy loam, there is no distinction observed in the selling price or rental values of the two types when used for general agricultural purposes.

The following table gives the results of mechanical analyses of the soil and subsoil:

Mechanical analyses of Orangeburg sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16516.....	Soil.....	0.8	18.5	15.0	41.0	7.5	9.1	8.1
16517.....	Subsoil.....	.5	15.0	20.6	42.9	4.4	7.5	9.8

LEON FINE SAND.

The Leon fine sand consists of a fine to very fine white sand 3 feet or more in depth. It contains but little coarse or medium sand and practically no silt or clay. A little organic matter is present in the soil, and, in some instances, the lower subsoil has a yellow tint where clay or sandy clay occurs just below it. This stratum of clay is not constant, for in many places the sand rests directly upon limestone.

The soil to a depth of 3 feet, as normally developed, is a fine, siliceous sand, quite uniform in texture, loose in structure, and destitute of the loamy qualities which the Norfolk fine sand possesses. The variations that occur are more generally attributable to peculiarities of the subterranean drainage than to differences in the nature of the material of either soil or subsoil. Where good drainage exists very little organic matter has accumulated in the soil. Where the surface is flat and the rock beneath evidently admits of little or no subterranean drainage, a thin layer of black fine sandy muck forms the top soil. This is seldom more than 3 or 4 inches in thickness, and its contact with the white sand beneath is sharply defined.

The Leon fine sand as it occurs in this county is found only in the flatwoods. The largest continuous area lies west of the Aucilla River above its junction with the Wacissa. Most of the surface is nearly level, but there are a few broad depressions leading from the banks of the Aucilla River toward Cow Creek. During the frequent overflows of the river these depressions fill with water.

In sections 9 and 10, T. 3 S., R. 4 E., the surface rises in places nearly 20 feet above the river bank and then slopes gradually back for about one-fourth mile before it merges into the general level. An attempt was made to grow corn and cotton on this higher ground, but little success attended the effort. Most of this area is covered with longleaf pine. Where the sand is exceptionally deep the pine is of poor quality and scrubby oak trees are numerous. The location of the numerous sinks and also of the river's course is revealed by the fringe of water oaks and cabbage palmetto.

It seems remarkable that this fine sand, which in most places is fairly well covered with vegetation, should be so destitute of humus. It is probably due to the thorough drainage and aeration which it receives during dry periods. The channel of the Aucilla River is sunk into the underlying rock 10 feet or more along the open part of its course and probably flows at an even greater depth beneath the natural bridges. Many of the sinks communicate with the river's channel. Thus this stratum of sand is most effectively drained whenever the level of the water falls below the surface of the limestone. On the west, at a distance of about a mile, where this subterranean drainage becomes ineffective, the white Leon fine sand merges into the darker Portsmouth fine sand.

The small areas of Leon fine sand west of the Wacissa River have much poorer drainage than the one just described. They are not well defined, usually grading into the adjoining swamps or Portsmouth fine sand, through a series of patches and tongues of alternating low and higher ground which may have a difference in elevation of less than 2 feet. But this difference often is sufficient to mark a distinction in the vegetation. The timber is of poor quality on the Leon fine sand and in places there is no undergrowth except short wire-grass. Its organic content is confined to the first 2 or 3 inches, while the white subsoil is thoroughly saturated. Where slightly better drainage prevails the subsoil assumes a yellowish tint, the soil has a little more organic matter, and the timber is of better quality.

None of this type is at present of much value for agricultural purposes. It affords some pasturage, but should remain forested.

The table following gives the results of mechanical analyses of a sample of the soil and of the subsoil.

Mechanical analyses of Leon fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
16492-----	Soil-----	0.8	3.4	5.2	88.3	5.1	2.0	0.4
16493-----	Subsoil-----	.1	3.9	4.7	81.9	7.6	1.5	0.3

PORTSMOUTH FINE SAND.

The surface soil of the Portsmouth fine sand is a black fine sand with a depth of 6 or 8 inches. The subsoil is a gray sand changing to reddish brown at about 24 inches below the surface.

The body of the soil consists of the finer grades of siliceous sand and the dark color is due entirely to the large amount of included vegetable matter. The latter, excepting the roots of living plants, is in that stage of decomposition corresponding to muck. Nearly all of it may be separated from the sand of a small sample by a few washings. It renders the surface loamy and retentive of moisture, and constitutes an important element of fertility. A considerable proportion of the coarser sand grains are not cemented by the organic content and after a rain are seen in little white patches upon the surface.

The contact between the soil and subsoil is well defined. The light-gray sand which forms the latter is destitute of all loamy properties. It contains practically no silt, clay, or visible humus. The dark reddish-brown layer which is usually found at a depth of 24 inches is characteristic. It is a fine sand carrying a very high percentage of ferruginous material. If wet it is slightly sticky, cohering when pressed in the hand, and on drying it remains feebly cemented. When the soil dries deeply this stratum forms a sort of hardpan. It is usually not more than a foot in thickness, graduating downward to a gray sand. In many places this deeper sand is of a light-yellow color, which indicates clay a foot or so below.

The accumulation of iron seems to be greatest near the margins of the permanent swamps. Under the latter the brown stratum is lacking. It is also deeper and not so well developed where the surface rises somewhat above the general level or has better drainage. It is not entirely impervious, but is so compact that free capillary movement of water is checked. In the rainy season the water table stands above this zone, but slowly falls and remains just below it during dry periods.

This soil is typically developed in the flatwoods. Small areas occur in the region which lies between Drifton and Aucilla, and in one of the larger swamps in the eastern part of the county. The surface is not level but usually presents a succession of low swells seldom rising

more than a few feet above the lowest depressions. The latter vary in size and outline from shallow limestone sinks a few rods across to incipient drainage lines hardly distinguishable from the permanent swamps. There are found a great many cypress swamps so small or with such poorly defined borders that they are not shown in the accompanying map.

The traveler who crosses these areas obtains the impression that the surface consists of a succession of low islands or sinuous ridges surrounded by swamps. This appearance is accentuated by the distribution of the native vegetation. The highest ground supports a rather open forest of longleaf pine, with a scattering, short undergrowth of saw palmetto and wire-grass. As the surface declines toward the bordering swamps or creeks the undergrowth thickens and is much higher, while the longleaf pine gives place to slash pine. The lowest ground, or meadow, along the streams is usually covered with a dense thicket of gallberry, ti-ti bushes, and briers, overshadowed by black pine and gum trees, with occasional soft maple, magnolia, and bay trees.

The ti-ti bays are broad, shallow depressions in the Portsmouth fine sand without even so well-marked outlets as most of the swamps possess. They receive their name from the characteristic vegetation, a crooked-stemmed, bushy shrub 8 to 10 feet high. Very little timber of any kind grows in these bays. The soil has more vegetable matter than most of the Portsmouth fine sand, but otherwise presents no difference.

None of the Portsmouth fine sand is under cultivation, except as a few acres have been included in fields of the Norfolk fine sand. In such instances the surface is dark, loamy, and easily cultivated.

The major part of this soil can be reclaimed only by a comprehensive system of drainage, which includes the clearance of the channels of the main creeks. Such a project would not be justified unless there were a greater demand for agricultural land than exists at present. The soil is not adapted to general crops. After a few years of cultivation the humus would disappear, leaving an ashy or gray colored sand about 2 feet in depth. What change, if any, the brown layer would undergo can not be definitely stated.

The following table gives the results of mechanical analyses of the soil and subsoil:

Mechanical analyses of Portsmouth fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16527-----	Soil-----	0.9	3.4	6.8	35.4	41.5	6.6	5.2
16528-----	Subsoil-----	.6	4.6	7.4	36.1	46.5	3.8	1.6
16529-----	Lower subsoil--	.4	4.8	7.3	33.9	47.9	3.0	2.6

NORFOLK FINE SAND.

The soil of the Norfolk fine sand is a very fine grayish siliceous sand with a depth of 6 or 8 inches. There is only a small amount of medium and practically no coarse sand in the material and the predominance of the finer grades of sand gives it a soft, loamy character. The color is darker and the resemblance to loam most pronounced in the virgin soil, or wherever the content of humus is above the average. When dry the surface is loose, but on the absorption of even a small amount of moisture it has a decided tendency to pack. In the heavier phases the grains feebly cohere, forming friable clods.

The subsoil to a depth of 20 inches is lighter in color, not so loamy, and somewhat more open in structure than the soil. The lower subsoil is usually a pale-yellow fine sand, and in some places it is white or light gray in color. There is not much difference, however, in texture between the soil and subsoil.

This type is underlain by a clay which is usually found about 4 feet below the surface. Near some of the larger limestone sinks, or where small local elevations occur, it may be encountered at a depth of 2 or 3 feet. Exposures in railroad cuts show that this stratum of clay has a very uneven surface. Within a few rods the difference in depth below the ground level may be several feet. The upper part is a light-yellow sandy clay, becoming heavier with depth. It grades downward to a mottled white and grayish clay, usually very soft, adhesive, and exceedingly retentive of moisture. The gray portion is markedly unctuous, resembling old tallow in consistency. On drying it has a tendency to separate from the white part into cubical fragments. It is derived from and immediately underlain by a limestone rich enough in phosphate to have attracted attention to its commercial possibilities. Fragments of this rock occur in the soil, and occasionally pieces of chert from a few inches to a foot in diameter are found upon the surface.

The Norfolk fine sand comprises the best drained land in the flat-woods. The surface consists of low or gently undulating divides between the drainage lines. With the exception of an occasional sand ridge the most pronounced of these elevations does not exceed 10 feet. The native vegetation consists principally of longleaf and slash pine, with the usual short undergrowth of saw palmetto, gallberry bushes, and wire-grass.

This is a warm, early, and easily cultivated soil, and is adapted to a considerable variety of crops. Much of it is now under cultivation, almost exclusively to corn and cotton. The average yield of the former without fertilizers of any kind is about 12 bushels per acre. Short-staple cotton produces from one-fourth to one-third bale and the long-staple or Sea Island about 300 pounds of seed cotton per acre. Sugar cane does well. Table sirup of good quality is made for home use and to supply the small local demand. The total

acreage in sugar cane is very limited and but little attention is given the proper fertilization ^a of the fields or the preparation of the product for the general market. Winter oats, cowpeas, and velvet beans may be grown successfully, and the same is true of all early truck crops and most of the varieties of fruit adapted to this region.

As to the adaptation of this type to special crops, too much emphasis can not be placed upon the importance of drainage and the maintenance of humus in the soil. Some of the lightest phases are of little agricultural value, and the same is true of many small areas in the flatwoods which are so low that drainage is impracticable. Most of the type, however, is susceptible of great improvement. Many fields would be benefited by a few open ditches so located that an excess of rainfall during any period of the growing season would not hold the water table within 2 or 3 feet of the surface. The topography, the texture of soil and subsoil, and, in most instances, the position of the underlying clay render such an improvement practicable.

If the soil were well supplied with humus, which may be increased by plowing under or pasturing some leguminous crop once every two or three years, its capacity to maintain an equable supply of moisture could be measurably improved. The subsoil invariably has a good store of water, especially if it is immediately underlain by the clay, while the texture of the sand above admits of good capillary connection between it and the soil. With all crops frequent shallow cultivation would be preferable to the ridge method now practiced.

The adoption of the methods here suggested would increase the productive power of the soil and enable crops to withstand seasonal extremes of moisture and temperature. The water-logged condition of the subsoil, which is not an infrequent occurrence, would be prevented and the daily range of the surface temperature would be reduced.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Norfolk fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16506.....	Soil.....	0.6	5.0	6.4	49.5	31.6	4.2	2.4
16507.....	Subsoil....	.2	5.7	6.4	45.5	36.0	4.9	1.6

NORFOLK VERY FINE SANDY LOAM.

The soil resembles that of the Norfolk fine sand in color, composition, and texture. It is underlain by a fine gray sand which grades

^a See Bulletin No. 93, Bureau of Chemistry, U. S. Department of Agriculture, p. 93. These plats were located on Norfolk fine sand.

downward to a sandy clay. This clay is similar to that which underlies the Norfolk fine sand, and the distinction between the two types is based upon the difference in depth to this clay substratum. In the small areas mapped as Norfolk very fine sandy loam the clay lies from 12 to 24 inches below the surface, thus forming the subsoil. Where it is found at a depth of 12 or 15 inches the contact between it and the sand above is usually well defined. Where the clay lies much deeper there is a zone above it, a foot or more in thickness, in which the relative proportions of sand and clay vary greatly. If it is very heavy it is usually mottled gray and light yellow, becoming white, or nearly so, as it merges into the deeper subsoil. If the subsoil contains a high percentage of sand it is generally yellow in color, indicating better aeration and subdrainage.

The surface has greater relief than is common to the flatwoods soils. Small mounds and ridges rise somewhat above the general level and limestone sinks are of frequent occurrence.

After the subsoil becomes saturated it retains moisture long after the surface is in good condition for tillage. In wet seasons all crops are more or less injured. Cotton is especially liable to damage by "scalding." In dry years this soil gives good returns of all crops that have been tried. The cultivated acreage is small, but could be extended and greatly improved by drainage.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Norfolk very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16514-----	Soil-----	0.7	3.6	2.3	51.1	35.3	4.9	1.7
16515-----	Subsoil----	.2	2.0	2.0	36.7	21.1	5.6	32.8

GADSDEN SAND.

The Gadsden sand consists of a dark-gray to black sand from 8 to 15 inches deep, underlain by an incoherent light-gray or white sand. The sands consist of the finer grades of well-rounded quartz grains with which a large amount of organic matter has become mixed, giving the soil a loamy appearance.

The type occupies areas of limited extent, the largest occurring in the vicinity of Lloyd. A few small areas occupying depressions were mapped in the northeastern corner of the county. Where most typically developed the soil occurs in the form of narrow strips adjacent to streams. It occupies a slightly higher position than Meadow and represents material which has been subjected to more or less swampy conditions.

This soil is derived from the Columbia sands, the dark color being due to incorporated organic matter. On account of its low-lying position and nearly flat topography the Gadsden sand, as it occurs in Jefferson County, is poorly drained. In color, position, and texture the surface soil closely resembles the Portsmouth fine sand, while the subsoil is much like the subsoil of the Norfolk sand. Unlike the subsoil of the Portsmouth fine sand, no iron-stained stratum of sand is found, and for this reason the type was separated from the Portsmouth soil. When the surface is broken and leaching takes place the organic matter is soon washed out, leaving only the white sand. This is particularly noticeable in the roads, which have become white, in strong contrast to the black soil of the adjacent fields.

If drained the Gadsden sand would doubtless prove admirably adapted to the production of vegetables, celery, onions, cabbage, and melons. By reason of its poor lasting qualities, due to its light character and porous subsoil, the results attained might not justify the expense of draining, except under methods calculated to keep up the humus content. The Gadsden sand is more extensively developed in Gadsden County, where the type was first mapped. It is practically uncultivated. The native timber growth consists of pine, magnolia, bay, wire-grass, and saw palmetto.

The results of mechanical analyses of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Gadsden sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16488.....	Soil.....	0.2	4.1	7.6	57.0	20.1	8.5	2.5
16489.....	Subsoil.....	.4	2.9	6.8	66.5	13.9	5.9	3.5

GADSDEN SANDY LOAM.

The Gadsden sandy loam consists of a brown or reddish-brown sandy loam from 8 to 15 inches deep, underlain by a brown or yellowish-brown heavy sandy loam or loam.

The type is found in small areas closely associated with the Orangeburg fine sandy loam. It occurs almost exclusively in the northwestern corner of the county, where it occupies small depressions and flat areas along stream courses. It is naturally poorly drained and is an unimportant type on account of its limited extent. It represents coluvial material with which considerable organic material has become mixed. No crop yields were obtainable, but where cultivated along with associated soils the crops grew well.

No samples of this soil were collected for mechanical analyses.

PORTSMOUTH FINE SANDY LOAM.

The soil of the Portsmouth fine sandy loam to a depth of 8 inches is a fine sand, in which are found varying amounts of organic matter. The subsoil to 24 inches is a fine gray sand of texture similar to the soil, grading downward to a light-colored sandy clay, which extends to 36 inches. The drainage conditions have induced some peculiarities in the amount and distribution of the organic content, which with the differences in topographic position differentiate this type from the Swamp type.

The Portsmouth fine sandy loam occurs on level interstream areas having a slight marginal inclination toward the drainage lines. This slight difference in relief gives some surface drainage, but the subsoil is usually saturated.

The type is found only west of the Wacissa River in the two southern townships. Two phases were recognized. The area south of the Pin Hook sinks has a very black soil, 3 or 4 inches deep, consisting of well-decomposed vegetable matter mixed with fine sand, underlain by a nearly clear gray or white sand slightly coarser and somewhat more sharp, or gritty, than most of the sand of the flatwoods. The contact between it and the soil above is very clearly defined. In some of the depressions a thin stratum of muck resting directly upon white sand forms the soil. At 10 to 15 inches below the surface this light-colored sand grades into a grayish sandy clay. In some places it is mottled gray and pale yellow with brown iron stains. It is usually saturated, soft, tenacious, and becomes lighter in color with depth. Below 40 inches it is a white, unctuous clay, containing some white flakes and small fragments of cherty rock. Boulders of rough, weathered chert are numerous in places, and occur occasionally in all areas of this type.

The area between the Pin Hook sinks and the western county line is nearly level, but most of the surface has better drainage than the area farther south. The soil resembles that of the Portsmouth fine sand. The vegetable matter is well distributed through the soil instead of being concentrated in the first 3 or 4 inches. The intermediate stratum of sand is not so light in color nor is it so noticeable a part of the soil section. The sandy clay of the subsoil is a dull yellow in some places instead of gray or white, but otherwise it is identical with the sandy clay previously described.

The poor drainage is due only in part to its topography. The impervious nature of the clay and the rock which is only a few feet below the clay prevent effective subterranean drainage. The water which falls upon the surface escapes mainly by evaporation and lateral seepage.

Longleaf pine is the principal timber growth on this soil. It usually forms an open forest with a short but rather dense undergrowth of saw palmetto and wire-grass.

With proper drainage much of the Portsmouth fine sandy loam would be adapted to a considerable variety of crops. If the average level of the water table were permanently lowered, aeration would cause a change in the color and condition of the soil, and to some extent of the subsoil. The vertical distribution of the organic matter would be more uniform in the former, and the permeability of the latter would be increased.

The results of mechanical analyses of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Portsmouth fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16483-----	Soil-----	0.0	4.3	7.4	60.3	9.0	14.2	4.5
16484-----	Subsoil----	.0	2.0	4.4	48.0	12.5	19.7	13.8

SANDHILL.

In the southwestern part of the county there are several small sandhills. These hills rise from 15 to 20 feet above the surrounding surface and are quite conspicuous, since the elevations in this section do not generally exceed 8 to 10 feet.

The material composing these mounds consists of medium to fine white sand containing but a small amount of organic matter. These mounds are covered with a sparse growth of low bushes and saw palmetto, together with scattering pines upon the slopes. They probably owe their origin to drifting of the coastal sands by the wind, at a time when the shore line was farther north than at the present time. These sandhills are at present of no agricultural value.

Mechanical analysis of Sandhill.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16,538-----	Soil-----	0.0	11.7	15.8	67.7	3.2	0.9	0.5

MEADOW.

The Meadow mapped in Jefferson County represents low-lying, narrow strips of land adjoining stream channels. These flat, poorly drained areas are subject to overflow and some remain in a semi-swampy condition.

The soil is of variable texture. Along the smaller streams of the uplands it consists of a dark-colored sand which may be underlain at various depths by a drab, brown, or gray clay.

The semiswampy phase of Meadow consists of gray or drab material overlying heavy clay of similar color. Often the surface material is lacking.

The better drained Meadow strips are sometimes cultivated to corn and fair yields are secured in favorable seasons.

The natural growth consists of pine, bay, magnolia, gum, cypress, and water oak. Cane, briers, and vines form an almost impenetrable mass bordering many of the streams.

SWAMP.

The Swamp embraces those soils which have such poor natural drainage that they are covered with shallow water during all or a part of the year. Small depressions where such conditions prevail and poorly drained areas in soil types have been indicated on the map by appropriate symbols.

Several extensive swamps and innumerable small ones are included in the survey. The largest swamps are located in the flatwoods. The soil of the swamps found in the uplands usually consists of a medium to fine black mucky sand. The immediate surface is composed of vegetable material in all stages of decay. The relative amount of such matter decreases with depth and at 12 to 18 inches the material grades into a grayish sand similar in texture to that of the surface. A stiff clay underlies this sand, but it is not usually found within 4 feet of the surface of the muck. In some of the large isolated swamps, which are really shallow lakes, a heavy clay loam overlying a clay subsoil is found. A few places of this character were found to have a heavy clay loam overlying a clay subsoil. The swamps of the flatwoods differ in several respects from those of the uplands. In many instances they owe their origin to the impervious nature of the substratum of clay and the configuration of the underlying limestone. The geological structure and the slight relief favors a slow lateral movement of water at a comparatively short distance below the surface. It accumulates in the depressions and, if no subterranean outlets exist, or if they are inadequate, can only escape through the obstructed stream channels, or by evaporation.

The black sandy muck of the surface seldom exceeds 18 inches in depth. It is fine to very fine in texture and the grayish sand below is essentially a quicksand.

Above the junction of the Aucilla and Wacissa rivers there is a small area which has much better natural drainage than most of the type. Though subject to overflow, the surface is generally free from standing water. The soil is a fine sand, or, in some of the lower places, where rock is found within 3 feet of the surface, it is a brown fine sandy loam, with a high percentage of organic matter. The subsoil is a drab fine sandy clay derived from the limestone. Weathered

fragments of this rock are found upon the surface and ledges of it are exposed in the river channels. All of this small area is heavily forested.

The characteristic vegetation of all the swamps is cypress and black gum, which occupy the submerged positions, with sweet gum, magnolia, bay, black pine, and occasionally soft maple, ash, and wateroaks, near the margins or wherever slight elevations bring the surface above the average water level. Cabbage palmettoes are numerous in the swamps near the coast and give the vegetation a decidedly tropical appearance.

The large swamp west of the Wacissa River presents some differences in the depth and character of the organic accumulations. In all the sections along the east side of T. 3 S., R. 3 E., there are peat beds varying from a few inches to several feet in depth. In many instances this material rests upon the limestone rock where the latter closely approaches the surface, but does not lie above the average water level. There are many ill-defined areas, usually not far from the Wacissa River, where the black muck grades laterally to brown fibrous material resembling peat. It is often covered with moss, is usually not more than a foot in depth, and invariably overlies loose, saturated sand. The timber consists of a scattered growth of scrubby pine.

Small elevations occur along the Wacissa River on which the soil resembles the Norfolk fine sand in texture. There are also canebrakes which have a somewhat more loamy soil than is usually found in the swamps. All of these have been included in this Swamp area, since they are small, almost inaccessible, and of no present agricultural value.

Borings to a depth of 40 inches in various parts of this extensive swamp showed that loose gray fine sand usually underlies the surface muck. If it were drained some areas of Portsmouth fine sandy loam would be found, but the greater part would be no more valuable for agricultural purposes than most of the land adjoining it.

The results of mechanical analyses of samples of soil and subsoil of Swamp are given in the following table:

Mechanical analyses of Swamp.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16,533-----	Soil-----	0.8	5.3	6.5	41.0	26.9	8.9	10.1
16,534-----	Subsoil-----	.7	5.3	6.0	41.0	33.0	6.2	7.4
16,535-----	Lower subsoil..	.2	3.9	3.8	29.3	29.7	6.2	29.5

MARSH.

Several small marshes are found near the coast. These are low, treeless areas covered with a growth of saw-grass. In most instances the soil is a muck to a depth of about 1 foot. The subsoil is variable in composition, usually containing considerable clay, which in its saturated condition is plastic, soft, and miry.

The general appearance of these marsh areas indicates that they were until recently shallow ponds which have become nearly filled with organic remains. The margins of these areas are being encroached upon by the characteristic water-loving vegetation.

A narrow border of salt marsh extends across the southern end of the county. The Gulf coast is nearly flat for a mile or more back from the shore. With the exception of a few, low "islands" and the channels of inlets, the sand is covered with a dense growth of water-loving rushes. The roots of this vegetation have bound the sand together in a peaty mass to a depth of several inches.

The roots of this vegetation have bound the sand together in a peaty mass to a depth of several inches.

Near the "timber line," or border of the Marsh area, the addition of earthy matter and the encroachment of fresh-water grasses is gradually converting the margin of the sea sands into fresh-water marsh. This condition or phase is of some value for pasture.

SUMMARY.

Jefferson County is situated in middle Florida. It extends from the Georgia-Florida line south to the Gulf of Mexico, a distance of nearly 40 miles. Its area includes about 585 square miles of rolling, gently rolling, and fairly flat country. There are two distinct physiographic divisions within the county. The larger consists of the northern two-thirds and forms the uplands, while the smaller comprises the poorly drained southern third known as the "flat-woods."

Jefferson County was organized in 1827, and Monticello was surveyed for the county seat at the beginning of 1828. It is the largest town in the county. The first settlers came from Virginia and South Carolina.

At present the farming is carried on mainly under the tenant system. About 23 per cent of the farms are operated by their owners. Farms vary in size from a few acres to several thousand. The average size of the farms, according to the census of 1900, is given as 77.1 acres, but the census classification considers each tenancy a farm and the average size holding is much greater than the figures given.

Cotton and corn are the principal crops grown, with hay, sugar cane, sweet potatoes, vegetables, and pecans as minor products. The

growing of shade tobacco, now in the first stages of development, gives promise of great success. The pecan is being successfully produced as an orchard nut, and much attention is also being given to nursery stock. There are six pecan nurseries at Monticello.

There is almost unlimited opportunity for the successful growing of truck crops for local and northern markets. Dairy products command good prices and a great variety of forage and pasture crops can be easily produced.

The county is well supplied with transportation facilities. Special industries requiring quick transportation have not yet developed to the point where cheap rates can be economically offered by the railroads.

The flatwoods region is sparsely settled and here agriculture has received little attention except along the foothills. Lumbering and turpentering are the chief industries.

The price of land in Jefferson County has increased greatly within the last few years, owing principally to the higher prices paid for lumber and turpentine and more recently to the introduction of special industries. There is still plenty of good land to be had at reasonable and in some instances very low prices.

The soils, consisting exclusively of sands and sandy loams, are varied. The upland soils are derived from the Lafayette formation, while the soils of the flatwoods owe their origin to the Columbia formation. Fifteen types of soil were mapped, of which the following have at present a low agricultural value, viz: Sandhill, Meadow, Swamp, and Marsh.

The Orangeburg series is confined entirely to the uplands and consists of two members, a fine sandy loam and sand. The Orangeburg fine sandy loam is the heaviest and strongest soil in the county and for cotton it is considered the best. It is also well adapted to Cuban filler leaf tobacco. The Orangeburg sand is a fairly good soil for cotton and corn but the yields average somewhat lower than upon the fine sandy loam. It is a very desirable soil for the growing of Sumatra wrapper-leaf tobacco.

The Norfolk series has four members, two of which are found in the uplands and two, the finer grades, in the flatwoods. On account of its wide crop adaptation the Norfolk fine sandy loam is the most important soil of the county. It is easily cultivated and responds readily to fertilization. It is adapted to cotton, corn, oats, sugar cane, truck, fruit, pecans, and tobacco. It is the most desirable soil for the growing of Sumatra wrapper-leaf tobacco under shade, and pecans thrive especially well upon it.

The Norfolk sand for the most part possesses a loamy texture, is retentive of moisture, and easily cultivated. Except in droughty seasons the same crops grown upon the fine sandy loam do well on

this soil. For trucking purposes the Norfolk sand is the better soil and near markets should be devoted to that industry.

The Norfolk very fine sandy loam if properly drained would prove a good soil for general farming, truck, and Sumatra leaf tobacco. The Norfolk fine sand is deficient in organic matter which may be supplied by green manure.

The Portsmouth series has two members, a fine sandy loam and fine sand. Immature drainage renders these soils at present unfit for cultivation. If artificially drained, and it is practicable to establish drainage systems, these soils should prove valuable for truck growing. The Portsmouth fine sandy loam is confined to the southern extremity of the county. It is low-lying and naturally wet, but should be a strong soil for corn and forage crops if artificially drained.

Besides these three main series which are found throughout the coastal plain country, two smaller series were recognized. The Gadsden series furnishes two members, a sandy loam and sand. The sandy loam occurs in the uplands and is made up of wash material. Cotton and corn yield good crops. The sand by reason of its topography is poorly drained, but would doubtless prove a good truck soil if drained artificially.

The Leon series has one member, a fine sand. It is a nonagricultural type of the flatwoods.

The greatest needs for accomplishing the permanent upbuilding of the soils are greater diversification and rotation of crops, the growing of leguminous crops, more thorough and systematic methods of tillage, the keeping of more live stock, and the use of improved, labor-saving farm machinery.

SOIL SURVEY OF MARION COUNTY, ALABAMA.

By ORLA L. AYRS, E. R. ALLEN, A. E. KOCHER, and H. L. WESTOVER.

DESCRIPTION OF THE AREA.

Marion County comprises an area of 472,896 acres, or approximately 739 square miles, and its outline is roughly that of an inverted L. It is situated in the northwestern part of Alabama, joining the Mississippi line. It is bounded on the north by Franklin County, on the east by Winston and Walker counties, on the south by Fayette and Lamar counties, and on the west by Lamar County and Mississippi.

The entire county is rough and hilly. In the southern and southwestern parts the hills are relatively low and rounded in outline, but in the central and northern parts the surface is rough and broken, some portions being almost mountainous.

The greater part of the county is drained by the Buttahatchee River and its tributaries. Bull Mountain Creek flows across the northwestern part, and the southeastern part is drained by Luxapalilla Creek, Little New River, and New River. These streams all reach the Gulf of Mexico through the Tombigbee River. A small portion of the county in the northeastern corner is drained by Bear Creek, which flows north to the Tennessee River. Nearly all of these streams have their source within the county. The large streams, especially Buttahatchee River

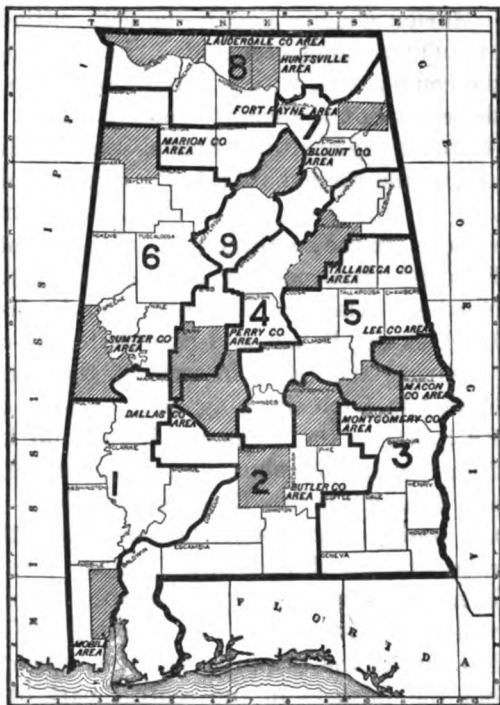


FIG. 12.—Sketch map showing location of the Marion County area, Alabama.

and Bear Creek, have swift currents and flow through deep, narrow valleys, making it possible to develop much water power.

The county was organized in 1818, and the first settlements were made a few years earlier. Owing to the long distance from any market town or shipping point and the general rough character of the country, its settlement was slow. A few families came in from year to year and took up land along the creeks where there was easy access to water, until scattered settlements were found over the entire county. The majority of these early immigrants came from the older States of Tennessee, North Carolina, and South Carolina. During the last twelve or fifteen years there has been a new immigration from the eastern counties of the State and from Georgia. These people for the most part have settled in the northeastern part of the county, selecting their farms on the tops of the broad, dividing ridges, where the land is less broken and can be cultivated with greater ease.

Marion County is still sparsely settled, not more than one-fourth of its area being occupied. There are no large towns. Hamilton is the county seat, with a population of about 500, and is situated near the center of the county some 16 miles from a railroad. The west Alabama Agricultural School was established here several years ago, and at the present time has a large enrollment of students from this and adjoining counties. Guin and Winfield are somewhat smaller villages, in the southern part of the county, on the St. Louis and San Francisco Railroad. Bear Creek is in the northeastern part, on the Northern Alabama Railroad, and furnishes a third shipping point. Hackleburg, Bexar, and Shottsville are other interior trading points.

During the early history of the county all supplies had to be hauled in from shipping points a long distance away—at first from Eastport, on the Tennessee River, and later, as railroads were built, from Iuka, Columbus, and Aberdeen, Miss. In 1887 the St. Louis and San Francisco Railroad was built across the southern part of the county, and about the same time the Northern Alabama Railroad crossed the northeast corner. The Illinois Central Railroad is now constructing a line across the northern part of the county, which will doubtless be in operation before the close of 1907. These lines make the shipping facilities much better than they have been, but the farmers in the central part of the county must still haul their produce 12 to 20 miles to reach a railroad.

The public roads are such as are usually found in an undeveloped region. Most of them follow the crests of ridges, so as to avoid the steep hills encountered in crossing stream valleys. They are worked over each season to the extent of filling up washed-out places, and the drainage ditches are cleaned out, so as to conduct the surface water to one side instead of allowing it to flow down the

wheel tracks and gully them. Over most of the county the region between the public roads is traversed by a network of settlement roads by which the people reach their homes. An abundance of good gravel is found at intervals over the county. If properly applied, this would make splendid roadbeds and the highways of Marion County could be put in excellent condition at a minimum cost.

Birmingham and Memphis are the nearest large cities, the former being 80 miles southeast and the latter 170 miles northwest of the county. Most of the supplies used in the county are shipped from these cities, and they ultimately receive a considerable part of the cotton, though it is sold by the grower in the local markets.

CLIMATE.

The climatic conditions in this county are very favorable for general agriculture and make it possible to grow a large variety of crops. The summers are long and warm, the growing season extending over a period of about seven months. Very little extreme heat is experienced, although the thermometer sometimes rises above 90° F. The winters are short and mild. Snow falls occasionally, but usually remains on the ground only a short time. The temperature rarely falls to zero or below.

The appended table, compiled from records of the Weather Bureau stations at Hamilton and Tuscumbia, Ala., and Columbus, Miss., gives the normal monthly and annual temperature and precipitation. The dates of the last killing frost in spring and the first in fall are given for Hamilton only.

Hamilton, as heretofore stated, is situated near the center of Marion County; Tuscumbia is 30 miles north, and Columbus, Miss., about 40 miles southwest of the area. The data from these three points show that there is but little variation in the climatic conditions over this section of the country. The rainfall is ample and quite uniform during the growing season, so that there is little danger of crops suffering from drought.

Normal monthly and annual temperature and precipitation.

Month.	Hamilton.		Tuscumbia.		Columbus, Miss.	
	Tempera- ture.	Precipi- tation.	Tempera- ture.	Precipi- tation.	Tempera- ture.	Precipi- tation.
	°F.	In.	°F.	In.	°F.	In.
January.....	41.7	4.88	40.2	4.92	44.2	4.77
February.....			43.5	4.78	44.6	5.00
March.....			52.7	6.80	53.8	7.00
April.....	59.9	5.09	62.0	5.18	62.2	4.77
May.....	71.5	2.57	71.0	3.00	72.8	3.16
June.....		5.00	79.6	4.80	81.3	4.76
July.....	79.8	4.54	78.7	4.43	83.2	5.60
August.....	80.0	2.78	78.2	3.50	81.9	3.72
September.....	76.0	2.79	70.0	2.97	76.1	2.55
October.....	62.4	2.48	62.0	2.10	63.9	2.06
November.....	62.2	3.80	52.9	3.34	53.7	4.79
December.....	46.1	4.55	43.8	4.38	46.6	5.25
Year.....			61.2	49.70	63.7	53.43

Dates of first and last killing frosts at Hamilton.

Year.	Last in spring.	First in fall.	Year.	Last in spring.	First in fall.
1897.....	Apr. 17	Oct. 25	1902.....	Apr. 2	Oct. 29
1898.....	Apr. 7	Oct. 21	1903.....	Mar. 26	Oct. 19
1899.....	Apr. 7	Nov. 2	1904.....	Apr. 4	Oct. 23
1900.....	Apr. 13	Nov. 12	Average.....	Apr. 6	Oct. 23

AGRICULTURE.

The early agriculture of Marion County was somewhat primitive, but included a greater variety of products than at present. Transportation facilities were wholly lacking, except for the old-time ox cart. The nearest shipping points were 40 or 60 miles distant, so that there was no inducement to produce more than was needed for home consumption. The first settlers made small clearings in the forests, where they cultivated corn and wheat and a few vegetables for their own use, and depended largely on wild game for their meat. As the settlements became more numerous live stock was introduced, the cattle and hogs running at large in the woods, in some cases becoming almost as wild as the native game. A few sheep were kept to furnish wool, from which the homespun garments were made. As land was cheap and abundant the farmer made no effort to keep it in a high state of cultivation, for as soon as a field became unproductive it was abandoned and another piece of land was cleared.

These general conditions remained much the same up to the time of the civil war. A few large plantations were established in the western part of the county, where slaves were kept and cotton was

grown for the market, but this was by no means general. During the last forty years, as the railroads came closer, so that shipping points could be reached with less and less trouble, there has been a gradual change. The production of wheat has been practically abandoned. The area of cultivated land has increased, and there has been a steady increase in the acreage planted to cotton, which has become the principal money crop. Corn is next in importance, nearly every farmer planting a portion of his land to it. However, many of them do not produce enough corn for their own use, preferring to grow a greater acreage of cotton and to make up the deficiency by purchase. Corn to supply this demand is shipped in from outside points at a heavy cost to the consumer. Oats are grown to a limited extent for home use, and a few farmers sow cowpeas each year. Much more attention should be given to the growing of cowpeas, as it is a valuable forage crop and is beneficial to the land. Nearly every farm has its garden, where sweet potatoes, tomatoes, cabbage, and other vegetables are grown. Peaches, apples, grapes, and small fruits are cultivated for home use, no attempt being made to produce them for market. With better shipping facilities peaches and grapes would prove profitable crops.

The live stock in the county consists almost entirely of mixed breeds. Nearly every farmer keeps a few hogs and one or two cows. Some of them, however, do not raise pork enough for their own use. A few have small flocks of sheep. Very little surplus stock is produced, although during the last year or two a few steers have been bought and shipped to Georgia for feeders. Throughout most of the county cattle and hogs range at will over the unoccupied land. Recently some of the "beats" in the county have been enforcing the stock law and preventing stock from running at large.

The adaptation of soils to crops has not as yet received much consideration, and practically the same crops are grown and the same methods of cultivation practiced over the entire county, without regard to the differences in the soil. It is the same with rotation of crops, a common practice being to grow the same crop on a field for several seasons. Some of the farmers plant corn and cotton alternately. Occasionally cowpeas are planted between the rows of cotton and corn and are gathered for hay or pastured after the corn is harvested. It is the custom after the field has been tilled for several seasons to let it lie fallow for two or three years. Frequently the surface is left unprotected and the land is damaged by washing. When this happens usually no attempt is made to reclaim it, the field being thrown open to the commons.

The preparation of the land for crops and its subsequent cultivation are done very largely with one horse. A light plow, consisting of a frame to which a variety of points or shovels may be attached,

is used throughout the season. The preparation of the land usually begins in January or February and continues until planting time. The soil is thrown up in a series of ridges, on which the rows of the next season's crop are planted. In most cases this is accomplished by throwing four furrows together, two from each side, with a light turning plow. Sometimes only two furrows are turned and the middle of the row is left to be broken up when cultivation begins. During the latter part of March or the first of April commercial fertilizer at the rate of 200 to 300 pounds per acre is drilled in the rows, and a few days later the seed is planted. This is the general practice for both corn and cotton. Two-horse turning plows, disk harrows, and other improved implements are being introduced gradually. Where these are used the land is generally plowed and harrowed in the usual way. In some cases the large plow is used to throw up the ridges, much the same as with the lighter implements. During the last few years the practice of contour cultivation and terracing the land has been introduced and has now become quite general. On the steep hillsides the soil washes easily, but the practice of contouring and terracing in a large measure prevents damage from this cause.

The labor problem does not assume the importance in Marion County that it does in many sections. The population is mainly white, and most of the farmers own the land they till. A few years ago considerable land was farmed by tenants, but in late years the tenant class has sought employment in the mines, on the railroads, and on public works, and at the present time little land is rented. Very few farmers attempt to cultivate a larger area than they can conveniently care for with the assistance of their own families. Most of the land is held in tracts of 160 acres or more, and of this usually not more than 30 or 40 acres are under cultivation. According to the census of 1900 less than 17 per cent of the area of the county was improved land. The acreage of cleared land has increased somewhat since then, but will not exceed 20 per cent at the present time. Agricultural land is cheap. The best improved farms will not bring more than \$30 an acre, and much of the improved land can be bought for \$10 to \$15 an acre. Large tracts of unimproved land suitable for agriculture can be bought at \$2 to \$5 an acre.

The conditions found in Marion County are much the same as those existing in any region partly developed, where land is cheap and plentiful. The methods employed are necessarily somewhat wasteful and tend to deteriorate the soil. Marked improvement can be made by the general use of improved machinery, more thorough cultivation, and systematic rotation of crops. Where one horse is used in preparing the land, improved implements will make it possi-

ble to employ two to four horses, and thus to accomplish much more work without extra help. Deeper plowing and more thorough cultivation will, even when the cost of the extra labor is considered, give larger profits. The practice of cultivating the land in ridges is necessary on the hillsides to prevent washing, but where the surface is level or only gently rolling level cultivation is better for both cotton and corn. The practice of contour cultivation and terracing on the hillsides is to be commended and should become universal.

Good farming demands a systematic rotation of crops, that is, changing the crop on a given field from year to year. A rotation which has been recommended for the State and which would doubtless prove satisfactory for Marion County is as follows: First year, corn with cowpeas planted between the rows at the last cultivation, the cowpeas to be pastured or plowed under; second year, the land plowed and sowed to oats, the oats to be followed, as soon as harvested, by cowpeas, which may be cut for hay or allowed to ripen and the peas gathered for seed; third year, cotton. The cowpeas will add organic matter and nitrogen—taken from the air—to the soil, leaving it in much better condition for subsequent crops.

More and better live stock should be kept. This should be confined to the farm instead of being allowed to run at large. A large quantity of animal manure can thus be added to the soil, and this will take the place of, or at least supplement, the commercial fertilizer now used. In order to carry much stock on the farm of average size, more forage crops must be grown. Cowpeas and alfalfa are two important crops in such a system. Alfalfa makes a splendid hay and a satisfactory pasture crop. It has been tried in the county and does well where the land is first treated with lime. The general introduction of this one crop will add much to the income of the farmers of Marion County.

SOILS.

The soils of Marion County are for the most part of sedimentary origin. The county lies near the southwestern extremity of the Cumberland Plateau, at a point where the Coastal Plain sediments of the Tertiary Period—mainly the Lafayette formation—form a thin covering over the sandstones, shales, and coal seams of the Carboniferous period which make up the plateau. The rocks here dip to the southwest. They lie near the surface in the northeastern and eastern parts of the county and are exposed along the hillsides and at the bottom of the valleys. Passing to the west and south, the overlying drift increases in thickness until all trace of the underlying rocks is lost. The Coastal Plain material laid down along the margins was subject to varying influences during the period of deposition. Because of this the soil-forming material varies widely. In many

places thick beds of gravel were formed, while at other points, presumably representing quiet bays, fine material was deposited, resulting in the formation of loam and fine sandy loam. Some of the gravel beds were cemented with iron, forming a conglomerate. At other points a brown sandstone highly impregnated with iron was formed. Farther out the deposition was more uniform, giving rise to the interbedded sands and sandy clay characteristic of the Gulf Coastal Plain. Since the final recession of the gulf waters stream erosion has been active and the county now presents a rough, hilly appearance.

These conditions have resulted in forming 10 distinct soil types: Guin fine sandy loam, Guin stony sandy loam, Guin gravelly sandy loam, Glenn loam, Glenn sandy loam, Norfolk silt loam, Ocklocknee fine sandy loam, Ocklocknee sand, Dekalb clay, and Rough stony land.

The Guin fine sandy loam is the most extensive. It is the predominant type throughout the southern and western parts of the county. Smaller areas are found along the ridges over the entire county. In the central and southern parts of the county there are several large areas where the country is very rough and broken, and there has been an accumulation of fragments from the brown sandstone or iron crust at the surface, making the soil quite stony. This has been mapped as a separate type under the name of Guin stony sandy loam.

Closely associated with the Guin fine sandy loam in the central and northern parts of the county is the Guin gravelly sandy loam. This usually occupies the hillsides below the Guin fine sandy loam, but in some cases the latter soil is lacking and the gravelly sandy loam extends over the entire hill. North of Guin the gravelly sandy loam forms a cap to the ridges, with the Guin fine sandy loam below. The Glenn loam is another sedimentary soil found in the northern and eastern parts of the county. It occupies the tops of broad ridges between the larger streams. Extending across the eastern part of the county is a rough, broken strip of country where the Coastal Plain sediments constitute a thin covering over the underlying rocks, and in many cases the disintegrating of the sandstone has influenced the soil. The greater part of this section is occupied by the Glenn sandy loam. Associated with this type are areas of shale from which the overlying sediments have been removed. The weathering of the shale has formed the Dekalb clay.

After the final recession of the Gulf waters the streams were quite active and terrace and bottom lands were formed along their courses. This gave rise to three soil types—the Norfolk silt loam, which occurs as a terrace along Buttahatchee River and some of the other streams, and Ocklocknee fine sandy loam and Ocklocknee sand, found in the

bottoms. In many places in the northern part of the county the streams have cut down into the underlying rocks and their courses are lined by sandstone cliffs or steep bluffs strewn with bowlders and fragments of sandstone. These areas were mapped as Rough stony land.

Lying at the junction of the geologic formations belonging to the Carboniferous and Tertiary periods, some of the soils found here owe their origin to the blending of material from both sources, while those derived wholly from sedimentary deposits were laid down under conditions somewhat different from those existing farther from the boundary line. Therefore the types are less uniform in this county than in regions where the formative processes have been less variable. These conditions have made it necessary to consider several of the types as having only a local distribution, while those correlated with the soils mapped in other areas vary somewhat from the true type.

The following table gives the names and areas of the several soil types shown in the accompanying map:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Guin fine sandy loam.....	181,824	38.5	Dekalb clay.....	23,808	5.0
Glenn sandy loam.....	73,000	15.6	Norfolk silt loam.....	17,216	3.6
Guin gravelly sandy loam.....	69,056	14.6	Rough stony land.....	14,272	3.0
Glenn loam.....	35,584	7.6	Ocklocknee sand.....	960	.2
Ocklocknee fine sandy loam.....	23,544	6.0	Total.....	472,896	
Guin stony sandy loam.....	23,082	5.9			

GUIN FINE SANDY LOAM.

The Guin fine sandy loam is a fine sandy loam 8 to 16 inches deep, with an average depth of about 10 inches. The surface over the greater part of the type is light brown or gray in color, frequently taking on a yellow or yellowish-brown tint below 2 inches. In some local areas the soil is decidedly red. The subsoil to a depth of 36 inches or more is usually a brownish-red sandy clay, but in some cases is orange or yellow and in others distinctly red. The sand content is somewhat variable, ranging from a mere trace to a quantity sufficient to give the subsoil the characteristics of a loam rather than a sandy clay. A small quantity of waterworn gravel is usually present in both soil and subsoil, and fragments of iron crust are occasionally encountered.

This is the most extensive soil type in Marion County. Except where broken by bottom lands or gravel ridges, it occupies all of the western half of the county and extends eastward along the southern boundary to within 6 miles of the east line. North of this occur

some large areas, while a few smaller ones are found scattered over the eastern range of townships.

The surface of the Guin fine sandy loam for the most part is hilly, and in some cases rough and broken. This is particularly noticeable around the headwaters of Beaver, Dugan, and Woods creeks. In the northern part of the county it occurs on the broad, rolling tops of the dividing ridges between Bull Mountain Creek, Bear Creek, and North Fork. The surface slope is always sufficient to provide ample drainage, and over the greater part of the type care must be taken to prevent excessive soil washing. The soil is derived from the stratified beds of clay and sand belonging to the Lafayette formation, which extends over the greater part of the county.

In its virgin state this soil was covered with a timber growth consisting mostly of oak and hickory, with scattering pine. Where it has been cleared and left in "old fields" the pine has sprung up more quickly than the other trees and occupies the whole field. The sandy character of the surface soil makes it an excellent soil for truck crops, small fruits, and peaches. Cotton and corn are the principal crops, and oats are an important, though secondary, product. Cotton yields from one-third to one-half bale per acre, though with good cultivation even better results can be obtained. Corn will produce 20 to 25 bushels per acre, and the yield of oats is about the same. Cowpeas are grown to a limited extent and prove a very satisfactory crop. Excellent results have been obtained with alfalfa where a dressing of lime was first applied to the soil.

The Guin fine sandy loam varies widely in value, owing mainly to the difference in topography. Improved farms can be purchased at from \$10 to \$30 an acre. Unimproved land sells at \$2 to \$5 an acre.

The average results of mechanical analyses of samples of this soil type are given in the following table:

Mechanical analyses of Guin fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16850, 16854-----	Soil-----	0.5	9.2	8.9	35.5	11.3	25.7	9.0
16861, 16865-----	Subsoil----	.9	7.1	6.8	28.4	5.5	24.1	26.9

GUIN STONY SANDY LOAM.

The soil and subsoil of the Guin stony sandy loam differ but little from the Guin fine sandy loam, the separation into a distinct type having been made because of its rough, broken topography and the presence of large quantities of iron crust and gravel conglomerate on the surface. This stony material has been formed by the accumulation of iron salts in certain strata of the soil, which has resulted in

the cementing of the gravel and sand into blocks or crusts varying from a few inches to 2 or 3 feet in width. •

This soil type is found in the southern and central parts of the county, with one large area in the northwestern part near Bull Mountain Creek. The surface of the Guin stony sandy loam is rough and hilly. Most of the areas occur around the heads of stream courses and on steep, narrow ridges, where erosion has been very active. This has resulted in the removal of large quantities of the fine material, leaving an accumulation of iron crust and coarse material at the surface.

Little of this soil has been cleared, the greater part being covered with the original growth of oak, hickory, other hardwoods, and pine. Its rough, broken surface makes it difficult to cultivate and causes excessive erosion when cleared. With the present low land values in this region, this soil should be left in forest, as larger returns may be obtained from the timber than could be had if the land were improved.

GUIN GRAVELLY SANDY LOAM.

The soil of the Guin gravelly sandy loam, from 8 to 12 inches in depth, is a light brown or gray sandy loam. The subsoil has about the same texture as the soil, and is usually yellow or gray, but in some cases red in color. The red color, however, is not as general as in the Guin fine sandy loam. Both soil and subsoil contain a large quantity of waterworn gravel. In some cases this may constitute 60 or 70 per cent of the soil mass.

This type is found principally in the central and northern parts of the county, where it occupies large areas. Small areas are scattered over the entire region occupied by the Guin fine sandy loam, many of them being only a few acres in extent and too small to show in the map.

The material from which this soil is derived consists of gravel beds laid down with the sands and clays of the Lafayette formation. In some cases the deposits occur as small pockets or lenses, while in others they represent extensive areas laid down as a shallow water or shore deposit. North of Guin the type occurs on the tops of ridges above the Guin fine sandy loam. Here it has served as a cap of resistant material, forming long, narrow, irregular, steep-sided ridges. Farther north the gravel beds are found as the lowest member of the Lafayette formation, resting on the Carboniferous sandstone and shales. The streams of this part of the county have cut through to the underlying rocks, often eroding them away, and the gravel areas form the steep valley walls, while above them are broad-topped ridges of Guin fine sandy loam.

Along Bull Mountain Creek the beds of gravel were partly cemented and have resisted the erosive action of the water much the

same as the solid rock. Along the north side of the valley there is an almost continuous line of gravel bluffs. The south side is more broken and stands out as individual hills and ridges.

Owing to position and texture, the soil water is rapidly removed from the Guin gravelly sandy loam and the soil is apt to suffer from drought. Where the surface is not protected it is badly damaged by erosion.

The greater part of the Guin gravelly sandy loam is still covered with the original forest growth, consisting largely of oak. In the less broken sections some of the type has been put under cultivation. Fair returns are obtained for two or three years, until the supply of humus in the surface soil is exhausted; then the fields are abandoned, and frequently waste by washing. Cotton will produce about one-fourth bale, and corn 10 to 15 bushels per acre. Grapes do well in this climate and doubtless would make satisfactory growth on this soil. However, most of the type should be left in forest.

GLENN LOAM.

The surface soil of the Glenn loam varies from a heavy fine sandy loam to a loam or silty loam, with an average depth of about 10 inches. The first inch is gray or grayish yellow; below that the color varies from a light yellow to a brownish yellow. The subsoil is a compact yellow loam, sometimes mottled with gray below 24 inches.

This soil is found in the northern and eastern parts of the county. In the northern part it occurs as irregular areas on the tops of the broad dividing ridges which separate the headwaters of North Fork, Williams Creek, and Bull Mountain Creek. In the vicinity of Bear Creek it occupies a broad, level to gently rolling area 1 to 3 miles wide, extending east and west for about 7 miles along the north county line. Several other large areas having the same topographic features are found south of this in the two eastern tiers of townships. The elevated position of the Glenn loam insures good natural drainage, but the surface water is carried off less rapidly than from any other upland soil in the county; hence little damage is done by erosion.

This type of soil is derived from weathered Coastal Plain sediments belonging to the Lafayette or possibly a more recent formation. In the vicinity of Bear Creek the material forms only a thin covering over the Carboniferous sandstone. Frequently the rock is encountered at a depth of 4 to 6 feet, and may have exerted some influence upon the character of the soil.

The timber growth on the Glenn loam consists of oak and hickory. As the forest is less dense, the native grasses make better growth than on the other soils of the county. Near Bear Creek practically all of the soil has been improved. In other sections of the county

the greater part is still forest. With proper cultivation the crop yields are as good on this soil as on any other. Cotton, corn, and oats are the principal crops grown. Cotton produces a half bale and corn 25 bushels per acre and oats about the same quantity. Apple trees make a strong, vigorous growth and produce a fruit of good quality. Peaches do not do well on this soil.

The close structure of this soil makes deep plowing necessary to obtain the best results. The plowing should be to a depth of 8 or 10 inches in order to produce a deep, friable seed bed. Cowpeas or some other crop for green manure should be plowed under every two or three years to add organic matter to the soil, making it easier to maintain a mellow, porous surface mulch. Where this has been done the Glenn loam in crop yields compares favorably with the best soils of the county.

The average results of mechanical analyses of this type of soil are shown in the following table:

Mechanical analyses of Glenn loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16254, 16832, 16834.	Soil.....	0.3	3.3	7.6	19.7	8.1	54.3	11.6
16255, 16833, 16835.	Subsoil....	.4	3.1	5.7	17.0	2.8	51.0	19.6

GLENN SANDY LOAM.

The soil of the Glenn sandy loam has an average depth of 12 inches, and varies from a loamy sand to a light sandy loam of gray or grayish-yellow color. The sand constituents range from the medium to the fine grades. At 12 or 14 inches the subsoil is reached. This is a yellow sandy loam somewhat heavier than the soil, or in some cases a true loam. It is usually mottled with gray and is more sandy below 30 inches. The fine material contained in this soil is usually sufficient to make it somewhat sticky when wet. In several places narrow strips of small, waterworn white gravel are found in the fields.

In the southeastern part of the county a phase of this soil differing slightly from the description was found occupying the tops of a few ridges. It consists of a fine sandy loam, having a brick, orange, or dark red sandy clay subsoil. It is more productive than the main type. The largest area of this phase occurs along the Tuscaloosa road north of Texas.

The Glenn sandy loam occupies an irregular belt several miles in width extending nearly across the county north and south near the east line. Smaller areas are found along Bear Creek and North

Fork and around the headwaters of Bull Mountain and Williams creeks. This section of the county is rough and broken, and the Glenn sandy loam is found in nearly all positions. Several large creeks have their origin here and are separated by long, narrow, dividing ridges. In some cases the Guin fine sandy loam or the Glenn loam forms a cap along the crests of the ridges, with the Glenn sandy loam occupying the slopes of the ridges and bottoms of the valleys. In other cases the Glenn sandy loam extends over the ridge, occupying the entire region. Owing to its position, the surface drainage is good. Moreover, the loose, open structure of this soil allows water to flow through it more readily than through the other soils of the area, and the surface is not injured by erosion to so great an extent. For the same reason the soil water is removed more quickly and it is the first soil to suffer from drought.

This soil is derived mainly from a thin layer of Coastal Plain material laid down over sandstone. The underlying rock has weathered to some extent, so that the soil is a mixture of two distinct materials. On the steep hillsides sandstone fragments are frequently found strewn over the surface.

The forest growth consists largely of white, post, and black-jack oak, with a few scattering pines. Very little of the soil is under cultivation. Cotton and corn are the principal crops, as in other sections of the county. The yields obtained are light and uncertain, and very little can be done without the use of commercial fertilizers. Potatoes, peanuts, and some of the truck crops would give the best returns on this soil. Peaches will do fairly well, but not as well as on the Guin fine sandy loam. The greater part of the Glenn sandy loam should be kept in forest, as the timber cut from time to time would be of greater value than the crops that can be produced on it.

The average results of mechanical analyses of this soil type are given in the following table:

Mechanical analyses of Glenn sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16846, 16848 -----	Soil -----	0.1	12.4	18.1	25.9	2.0	32.8	8.5
16847, 16849 -----	Subsoil -----	.1	13.2	17.8	25.3	2.3	26.6	14.7

NORFOLK SILT LOAM.

The Norfolk silt loam consists of 8 to 10 inches of light-brown or yellowish-brown silt loam, resting on a subsoil which is a yellow silt loam, becoming below 30 inches more sandy and sometimes mottled with gray. Local areas contain some small gravel in both soil and subsoil.

This is one of the types of limited development in Marion County. The largest areas are found along Buttahatchee River and its tributaries south and east of Hamilton and along New River and Little New River in the southeastern part of the county. A few small areas are found on Sipsey and Bull Mountain creeks in the western part of the county.

The Norfolk silt loam along the Buttahatchee River occupies a nearly level terrace, having an elevation of 30 to 50 feet above the river. In the unimproved areas of the soil the drainage courses are clogged with brush and decaying leaves, and this retards the flow of water, which stands on the surface and keeps the soil in a saturated condition. Where the land is improved and the stream channels are kept open the surface water is quickly removed and ample drainage is insured. Where the Norfolk silt loam occurs adjacent to the creeks in the western and southeastern parts of the county, there is no well-defined terrace as along the Buttahatchee River and the surface is somewhat more sloping, furnishing even better drainage than is found near the river.

This soil consists of alluvial material deposited by adjacent streams at a time when they occupied a higher elevation. It is derived largely from reworked Lafayette material.

The native timber growth consisted largely of oak, though hickory, elm, beech, and other hardwoods were found in limited numbers. At present most of the type is under cultivation. It is fully as productive as any soil in the county, and its level topography makes it a very desirable soil for farming. Cotton, corn, and oats are the principal crops. Cotton produces about one-half bale per acre, and under favorable conditions as much as 1 bale per acre has been grown. Corn yields 20 to 30 bushels per acre and oats about the same quantity.

The unimproved land is valued at \$5 to \$10 an acre, while the improved farms are worth \$15 to \$35 an acre.

The average results of mechanical analyses of the Norfolk silt loam are given in the following table:

Mechanical analyses of Norfolk silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16842, 16844-----	Soil.....	0.7	5.9	10.2	12.9	3.3	55.5	11.4
16843, 16845-----	Subsoil....	.6	5.4	9.0	11.7	1.9	55.0	16.1

OCKLOCKNEE FINE SANDY LOAM.

The Ocklocknee fine sandy loam is a bottom-land type found along the streams of Marion County. Owing to its origin and position,

the soil is somewhat variable. The predominant phase consists of a light-brown or gray fine sandy loam about 10 inches deep, usually containing enough clay to make it sticky when wet. The subsoil is a light-gray or mottled fine sandy loam or loam. Along the small streams the soil is quite sandy, while the areas along the larger streams are more loamy.

Large areas are found along Bull Mountain, Sipsey, Beaver, and Luxapallila creeks. Smaller areas are found along the creeks in the western and southern parts of the county. Along Sipsey Creek the bottom is half a mile or more in width. Here both soil and subsoil are ashy gray in color and the subsoil is frequently somewhat silty.

Near the small creeks and branches the surface of the Ocklocknee fine sandy loam slopes gently toward the stream course, but where it is adjacent to the large streams it is usually quite level. Some of these areas in their unimproved state are semiswampy. Most of them can be drained with little difficulty after the land is cleared. A few places are so low that it is not practical, however, to attempt drainage. In some cases the wash from the adjoining hills has been directed into these low places, filling them with sand. These areas are very productive. The soil has been formed from recent alluvial deposits laid down by the streams.

The native growth consists of bay, ash, alder, canebrake, and water-loving plants. When cleared and brought under cultivation the soil is usually planted to corn and cotton. It proves a very good corn soil, the yield ranging from 25 to 30 bushels per acre. The low-lying portions do not give as good results with cotton as the other soils, but where the land is high enough to insure good drainage the cotton yields compare favorably with any secured in the county.

OCKLOCKNEE SAND.

The Ocklocknee sand is the least extensive type in the county, being confined to a few small areas along the Buttahatchee River. The soil to a depth of 8 inches is a dark-gray or light-brown medium to fine sand, rendered slightly loamy by the presence of organic matter. The subsoil consists of a medium to fine sand varying in color from light gray to yellow.

The largest area of this type is found in the ox-bow bends of the Buttahatchee River south of Hamilton. Smaller areas occur near Pearces Mill and farther up the river. It occupies a level position 10 to 15 feet above the normal level of the river, but during periods of extremely high water parts of it are flooded. This, however, is only for a short time. Owing to its proximity to the river and the porous character of the soil, the type has ample drainage throughout the entire growing season.

The original timber growth was sycamore, beech, and other trees usually found near streams. Most of this soil has been improved and is planted to the ordinary crops, no attempt being made to select those best adapted to a light soil. The yields are somewhat less than on the Ocklocknee fine sandy loam.

The results of mechanical analyses of this soil type are given in the following table:

Mechanical analyses of Ocklocknee sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
16838-----	Soil-----	0.0	4.5	31.4	53.4	1.7	7.1	1.3
16839-----	Subsoil----	.0	6.0	25.3	59.3	2.0	5.4	2.1

DEKALB CLAY.

The soil of the Dekalb clay, to a depth of 8 inches, is a fine heavy loam or silty clay loam having a yellow or brownish-yellow color. Below 8 inches the material is a yellow clay loam or clay, usually mottled with gray. The subsoil has a slick, smooth, soapy feel when rubbed between the fingers. Small fragments of shale are usually present in the subsoil. The heavy texture of this soil makes it more difficult to cultivate than the other soils of the area, and great care must be taken to plow it at just the right time. When the moisture conditions are favorable the soil pulverizes readily.

The Dekalb clay is found in the eastern part of the county associated with the Glenn sandy loam. The soil is derived from a shale formation of the Carboniferous period. It overlies a sandstone formation and is frequently covered by Coastal Plain sediments or a second sandstone formation. Because of its position with reference to the other formations, much of the Dekalb clay is found on hillsides. In some places where the slope is very steep the overlying material has crept down over the shale, so that it has very little influence on the soil, and in such cases it is not shown on the map. Where the hills are less steep the influence of the formation above the shale is not so great, but is still sufficient to make the soil more sandy than the main type. Where the larger areas occur the overlying material has been eroded away and exerts no influence on the soil. Near Brilliant are a few nearly level areas where the decomposition of the shale is almost complete, and but few shale fragments are found in either soil or subsoil. In the southeastern corner of the county, below Mallards Creek, is a rough, broken area. The surface water is carried off rapidly, and owing to the somewhat impervious character of the soil there is not as much moisture retained in the soil as is needed for the best development of crops. Where unpro-

tected the surface soil has been removed, leaving the undecomposed shale exposed. This is most noticeable south of Mallards Creek.

The native forest growth consists largely of several species of oak and some hickory. Comparatively little of the Dekalb clay is improved and there is little available information as to its producing value. It would seem to be a fair corn soil, but not well suited to cotton. It is probably best adapted to pasture and forage crops. Bermuda grass would doubtless yield fair returns.

The ordinary shallow cultivation produces indifferent results on a soil having the heavy texture and close structure of the Dekalb clay. Deep cultivation will prove beneficial to a greater degree on this soil than on any other in the county, unless it be the Glenn loam. Care should be taken to increase the organic matter in the soil by plowing under cowpeas or some other soiling crop.

Below are given the results of mechanical analyses of this soil:

Mechanical analyses of Dekalb clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
16828-----	Soil-----	2.8	5.3	1.1	2.4	4.6	60.0	23.1
16829-----	Subsoil----	2.0	3.0	.9	1.6	.6	54.9	36.6

ROUGH STONY LAND.

The areas mapped as Rough stony land in Marion County occur almost exclusively along stream courses. They are due to the presence of sandstone belonging to the Carboniferous period, which is found lying under the other formations throughout the northeastern third of the county. The streams flow through tortuous channels at the bottom of deep, narrow valleys which they have eroded in the solid sandstone. The valley walls are usually steep, rocky slopes strewn with sandstone fragments and large boulders. Frequently the stream flows against sandstone cliffs 50 to 100 feet in height. These rocky slopes are usually covered with a stunted growth of oak and other hardwoods, and some of them afford a scanty growth of grass for pasture, though on the whole the type may be said to have no agricultural value.

SUMMARY.

Marion County is situated in northwestern Alabama next to the Mississippi line. It has an area of 739 square miles. The county is rough and hilly, some portions of the central and northeastern parts being almost mountainous.

Marion County is still sparsely settled. There are no large towns. Hamilton is the county seat, and Guin, Winfield, and Bear Creek are

small villages located on the railroad. Birmingham and Memphis are the nearest large cities. The county is now traversed by three railroads.

Marion County has a good climate, with long, warm summers and short, mild winters. The rainfall is sufficient for all needs and is well distributed through the growing season. Cotton is the main crop, with corn the next in importance. Not enough corn is grown to supply the local needs. Oats and cowpeas are grown to a limited extent. Garden vegetables and fruit are produced for home use. Little live stock is kept in the county. Cattle and hogs are allowed to run at large over unoccupied land, as formerly.

Shallow cultivation is the rule. The preparation of the soil and the further cultivation of the crop are done with one horse and usually with the same plow. Commercial fertilizer is generally applied at the rate of 200 to 300 pounds per acre for corn and cotton. The practice of contour cultivation and terracing on the hilly land has become quite general.

Not much of the land is rented, the large majority of the farmers being landowners. Little labor is hired, and few farmers cultivate more land than can be taken care of by the family without outside help.

Improved farms sell at \$10 to \$30 an acre and unimproved land at \$2 to \$5 an acre.

Of the nine types of soil in Marion County, the Guin fine sandy loam is the most extensive and the best general farming soil. It is cultivated chiefly to cotton and corn, but is adapted to a wide range of crops.

The Guin gravelly sandy loam is associated with the Guin fine sandy loam. The surface is rough and hilly. Some areas have been cleared and cultivated, but unless carefully handled the yields diminish rapidly. Most of it is timbered land and should remain in forest.

The Glenn loam is found in the northern and eastern parts of the county on the tops of broad, dividing ridges. The surface is level to gently rolling. The greater part is still in timber. Its crop value is about the same as that of the Guin fine sandy loam.

The Glenn sandy loam occupies the greater part of a strip 4 to 10 miles wide extending north and south across the eastern part of the county. This region is very hilly and rough. Most of the type is still in forest. Crop yields on the cultivated areas are light.

The Norfolk silt loam occupies only a limited area along the Butta-hatchee River and a few other streams. It is one of the best soils in the county. Nearly all of it is under cultivation and produces good crops of corn, cotton, and oats.

The Ocklocknee fine sandy loam consists of the bottom lands along the streams. Along the small streams the surface slopes gently and the soil is quite sandy. Where it is adjacent to the large creeks it is level and poorly drained and the soil is quite loamy. It is a good corn soil and where properly drained produces good yields of cotton.

The Ocklocknee sand is confined to a few small, low-lying areas along Buttahatchee River. In times of unusually high water it is sometimes flooded for a short time. The yields of cotton and corn are somewhat less than on the Ocklocknee fine sandy-loam.

The Dekalb clay, a heavy soil derived from weathered shale, occurs in the eastern part of the county. The surface varies from gently rolling to rough and hilly. Not much of it is improved.

The areas mapped as Rough stony land consist of steep, rocky slopes along the streams in the central and northern parts of the county. In many cases sandstone cliffs 50 to 100 feet in height occur in these areas. The Rough stony land has little or no agricultural value.

SOIL SURVEY OF TALLADEGA COUNTY, ALABAMA.

By CHARLES N. MOONEY and CHARLES J. MANN.

DESCRIPTION OF THE AREA.

Talladega County, Ala., is situated just northeast of the geographical center of the State. Its southern boundary lies about 7 miles north of the parallel of 33° north latitude, and the county extends northward 39 miles, with an average breadth of about 20 miles. The meridian of 86° west from Greenwich passes through the county only a few miles east of Talladega. The western boundary of the county is formed by the Coosa River, which flows in a tortuous course in a generally southwestern direction, the counties touching the river on the other side being St. Clair and Shelby. On the north Talladega County is bounded by Calhoun County; on the east by Cleburne and Clay, and on the south by Coosa. The county comprises an area of 479,808 acres, or approximately 750 square miles.

The county is made up of two main physiographic regions. About one-fourth

of its area, the extreme eastern part, is occupied by an extension of the Appalachian Mountain system, and consists of a much dissected plateau. The tops of the ridges have an average elevation of a little more than 1,000 feet and the narrow valleys are some 200 feet lower. Into this plateau extends a sharp mountainous ridge reaching at its highest point nearly 2,000 feet above sea level,

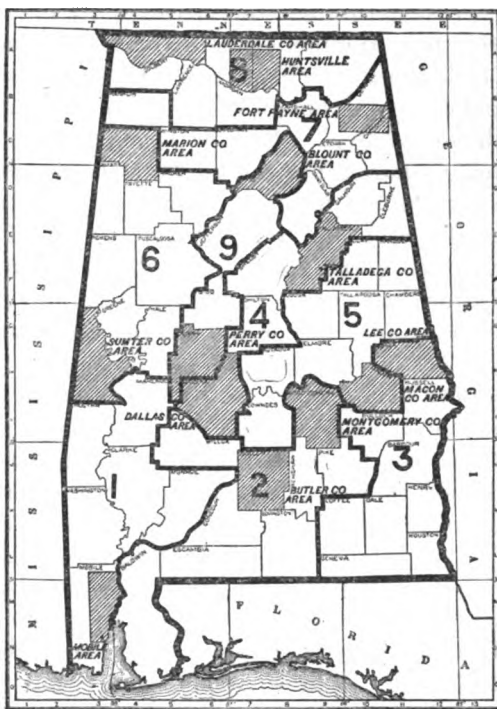


FIG. 13.—Sketch map showing location of the Talladega County area, Alabama.

which is the highest point in the county. The remaining three-fourths of the county is a part of the Coosa Valley, which is really an extension of the Great Valley of Virginia. The topography here is complex, the term "valley" being applied to a general trough or depression where the surface varies from rolling to ridgy, with some elevations reaching to a height of 1,500 feet or over.

There are thus many subsidiary valleys within the county, the main ones following the courses of the larger streams and with irregularly defined boundaries, the principal of which are the Choccolocco, Talladega, Tallaseehatchee, and Cedar creeks. There is also a narrow, rather obscure, valley following along the western edge of the metamorphic belt. The central part or trough of all these valleys is gently undulating, rising to hills on the sides and often with hills and ridges within themselves.

Passing through the central part of the county to the southwest from near the point where the Chehawhaw empties into Choccolocco Creek is a monoclinical mountain ridge called the Talladega Hills, the highest point being Mount Alpine, with an elevation of 1,551 feet above sea level. At Nottingham, on Talladega Creek, it terminates, being separated by a fault from the Kahatchee Mountains, to which it was no doubt formerly connected, the connecting ridges being thrust to the east and forming the valley of the Tallaseehatchee. The Kahatchee and Katala mountains occupy a large area in the southwestern part of the county. These mountains have steep slopes on their western face while on the east they are flanked by one or two parallel lower ridges with gentler slopes. The central-west part of the county along the Coosa River is a much dissected plateau, the top of which is something like 600 feet above sea level and about 200 feet above the Coosa River. Its topography consists of steep, irregular-shaped ridges or hills with narrow intervening valleys. The Coosa River in its course along the western boundary of the county falls from about 500 feet to something less than 400 feet.

The drainage is into the Coosa River. This stream, which flows southward, is a wide, deep stream, except in its rapids or shoals. The main tributaries entering from the county are Choccolocco, Talladega, Tallaseehatchee, and Cedar creeks, the three first mentioned being large streams and having many tributaries. In most parts of the courses of these streams they have considerable fall and would afford much water power. They are utilized now to some extent in running grist and saw mills. From Riverside, or Lock No. 4, the Coosa River is navigable up to Rome, Ga., and then up its main tributaries for some distance, and flat-bottom river steamboats ply throughout the year. Below Lock No. 4 to its mouth or its junction with the Tallapoosa River to form the

Alabama it is not navigable, because of the numerous rocky shoals or rapids.

The first permanent settlement in what is now Talladega County was made between 1828 and 1830, about 6 miles southwest of the present city of Talladega, at a place now known as Mardisville. There was also a small settlement started about this time on Talladega Creek, where the Louisville and Nashville Railroad now crosses that stream. Talladega was begun in 1832, the year that Talladega County was established, though it was not until 1834 that the county was organized, and the lands, which had been bought from the Indians, surveyed and offered for sale. Until 1837 these places were considered as mere trading posts. The pioneer settlers were of English descent and came from Georgia, the Carolinas, and Tennessee. Settlement gradually extended over the county, settlers continually coming in from older communities farther north. Since the civil war a few people from Northern States have settled in this county, attracted by the climatic conditions and the comparatively cheap lands. The accessions of this class are increasing, and land values are advancing as the number of available farms grows less. There is a spirit manifest in this State, as in other Southern States, to welcome foreign immigrants, and this section will no doubt in time receive its quota. The population of the county is largely rural and is well distributed, except that the rougher and less desirable lands are sparsely settled. The Twelfth Census reported the population of the county as 35,773, of which over 5,000 was then in Talladega, the county seat. Besides this city there are a number of small towns, the largest of which has probably about 1,000 population. Until the establishment of cotton factories and iron furnaces, which has occurred in comparatively recent time, all these were dependent upon the agriculture of the county for support. Talladega now has a population estimated at 7,000. It is centrally located and the railroad center of the county, four railroads passing through it. Its manufacturing interests are the largest in the county, three cotton mills, two oil mills, and an iron furnace and other smaller plants being located there. It is also the home of the State school for the deaf, dumb, and blind, of a seminary for young ladies, and of an important college for negroes. Talladega has all the modern conveniences of a city—waterworks, sewerage, electric lights, and fire department. Recently it has improved its sidewalks by laying over 14 miles of cement walks. Sylacauga, situated in the southeastern part of the county, at the junction of the Louisville and Nashville and the Central of Georgia railroads, is the next largest town, with a population of about 1,000 within its corporate limits. It is a thriving business place, and it is here that the Fourth Congressional District Agricultural School is located. Childersburg,

in the southwestern part of the county, is also an important town. Other towns of importance are Sycamore, Lincoln, and Munford.

The transportation facilities are exceptionally good. The county is traversed by the Birmingham and Atlantic Railroad and important branches of the Southern, the Louisville and Nashville, and the Central of Georgia systems. These roads have been in operation twenty years or more. The Rome and Selma division of the Southern and the Anniston and Calera branch of the Louisville and Nashville traverse the county from north to south, each reaching Anniston and affording connections with Atlanta, Ga., Chattanooga, Tenn., Birmingham, the largest city in the State, and Montgomery, the State capital. Another division of the Southern Railway crosses the northern part of the county, connecting Chattanooga, Tenn., with Birmingham. The Columbus, Georgia and Birmingham division of the Central of Georgia Railroad crosses the southern part of the county, reaching Birmingham and south Georgia points. The Birmingham and Atlantic crosses from Talladega westward to Pell City, in the adjoining county, connecting with the Southern Railway, and at Coal City with the Seaboard Air Line for Birmingham, and to the east with Chattanooga and Atlanta. It also enters an important coal field, known at the Coosa field. The Atlanta, Birmingham and Atlantic Railroad, which crosses centrally through the county and is nearly completed, will give direct connection between Atlanta and Birmingham and also reach the seaport town of Brunswick, Ga. There have been a number of narrow-gauge roads in operation in the past for transporting lumber, and one made standard gauge is still in operation in the southern part of the county, extending into Coosa County.

The wagon roads, especially the more important ones, are kept in fairly good condition. There is plenty of rock material at hand for macadamizing the roads, and no one thing would do more to improve agricultural conditions than systematic road improvement.

Cotton, the leading farm product, is sold in the local market towns of the county and adjoining counties. The market of the future for farm products other than cotton will undoubtedly be largely Birmingham, for with the development of the iron industries and coal mining this city is growing rapidly and in time will draw upon a large section of the surrounding country for its supplies. The demand for vegetables and poultry products is increasing as manufacturing establishments increase, and such products find a ready sale locally at the present time.

The principal manufacturing industries represented in the county are cotton mills, of which there are six; two oil mills; iron furnaces, of which there are three in operation; and numerous sawmills. These

make a large demand for labor, which, for the most part, except in the cotton mills, is negro.

The rural free delivery of mail is in operation practically in all parts of the county. A few rural telephone lines are also in operation and lines are gradually being extended.

CLIMATE.

The appended tables, showing the mean monthly and annual temperature and precipitation and the dates of last killing frosts in the spring and the first in the fall, were compiled from the records of the voluntary observer stations of the Weather Bureau at Talladega and at Lock No. 4. Both these stations are located within the county, the former centrally and the latter on the Coosa River, in the extreme northwestern part. The observations extend over a period of sixteen years for Talladega and nine years for Lock No. 4. As shown by the table the mean for the summer season is slightly over 79° F. and the winter mean about 45° F. The temperature falls below zero occasionally, and rises sometimes to 100° F. The cold spells, however, are short, and are most likely to occur the latter part of February or the first of March. They are sometimes attended by light snowfalls. The mean annual precipitation is 48.54 inches at Talladega and 50.65 inches at Lock No. 4, the heaviest rainfall occurring during the winter months and in July and August, while the least occurs in September and October.

The average date for the last killing frost in spring is April 4, and for the first in the fall November 1. The actual dates for a series of years are given in the table. Six months is the average length of the growing season, which is sufficient for the maturing of all crops.

Normal monthly and annual temperature and precipitation.

Month.	Talladega.		Lock No. 4.		Month.	Talladega.		Lock No. 4.	
	Tem- pera- ture.	Pre- cipita- tion.	Tem- pera- ture.	Pre- cipita- tion.		Tem- pera- ture.	Pre- cipita- tion.	Tem- pera- ture.	Pre- cipita- tion.
	° F.	In.	° F.	In.		° F.	In.	° F.	In.
January.....	44.5	4.51	41.6	5.60	August.....	79.3	5.06	79.7	4.18
February.....	45.8	6.11	42.0	5.68	September..	74.3	2.46	74.0	2.19
March.....	56.6	6.22	54.7	5.55	October.....	64.2	2.41	63.3	2.78
April.....	62.1	3.26	59.1	4.27	November..	52.1	3.08	52.4	2.88
May.....	70.5	2.91	70.7	3.87	December...	44.1	4.08	42.8	4.43
June.....	73.4	3.85	77.2	4.14	Year..	62.7	48.54	61.5	50.65
July.....	80.4	4.59	80.3	5.08					

Dates of first and last killing frosts.

Year.	Talladega.		Lock No. 4.		Year.	Talladega.		Lock No. 4.	
	Last in spring.	First in fall.	Last in spring.	First in fall.		Last in spring.	First in fall.	Last in spring.	First in fall.
1897.....	Mar. 26	Nov. 17	Mar. 26	Oct. 30	1902.....	Apr. 2	Oct. 29	Mar. 20	Nov. 28
1898.....	Apr. 9	Oct. 23	Apr. 8	Oct. 27	1903.....	Apr. 6	Oct. 25	Mar. 2	Oct. 25
1899.....	Apr. 8	Nov. 4	Apr. 8	Nov. 3	1904.....	Apr. 4	Oct. 23	Mar. 16	Oct. 23
1900.....	.....	Nov. 8	Apr. 1	Nov. 9	Average..	Apr. 4	Nov. 1	Mar. 25	Nov. 3

AGRICULTURE.

In the early days Charleston, S. C., and Augusta, Ga., were the nearest markets to Talladega County. At a later date products were rafted down the Coosa River at high water to Wetumpka, which is just above where this stream joins the Tallapoosa to form the Alabama River. From Wetumpka the river was navigable to Mobile, where trading could be done. But rafting was hazardous and never followed extensively. Under these conditions whatever the pioneer produced must of necessity have been mainly for home consumption. The principal crop was corn, which continued to be the leading staple until 1880. Some cotton also was grown, and this, with a little wool—sheep having probably been introduced soon after settlement—was used in the manufacture of homespun clothing. Cotton production must have greatly increased, for about 1840 the first power gin was in use. In 1850 the census showed a production of 8,509 400-pound bales for the territory now included in Talladega and Clay counties, though the latter was so sparsely settled as to be a negligible factor in the production. Ten years later the production had reached over 18,000 bales.

According to the census of 1850 there was about 380,000 acres in farms, one-third of which was improved. At this time a number of new field crops had been introduced. Besides corn and cotton—the production of the former being about 716,000 bushels—the next two important crops were oats and sweet potatoes. The production of oats was 114,550 bushels. Other cereals were also grown, which in order of importance were wheat, rice, and rye. It is interesting to note that by the next census the production of oats had decreased nearly one-half, while that of wheat and rye had greatly increased, and that over 3,000 bushels of barley was produced. The production of sweet potatoes was also less, but this may have been simply a seasonal fluctuation. The production of Irish potatoes increased, being in 1860 about 12,000 bushels, which was three times that of 1850. Peas and beans were also reported as important field crops in 1850. In that year the value of the live stock was placed at a little over half a million dollars, and by the close of the next decade at nearly

double that figure. By 1860 large plantations were common. It is said that the farms were kept in good condition, the lands being prevented from washing, and crop rotation being practiced quite extensively. In the late fifties railroad construction had begun, and in 1859 what is now a part of the Southern system was in operation between Selma and Talladega, and ten years later this line was extended to Anniston. As settlement advanced, county roads were established connecting the different places, and transportation was greatly facilitated.

During the civil war farming operations were to a great extent suspended in this county, and at its close, there being little capital at hand, the work could not be resumed on the former scale, so that production was necessarily curtailed. Since 1870 the conditions have gradually improved. The following twenty years marks a period in which all the railroads, with the exceptions previously mentioned, were built and put in operation. These railroads have been an important factor in opening up and developing the resources of the county. After the war the price of cotton, which had gone as high as 60 cents a pound, began to decline, though it continued at a remunerative figure for a long period of years. Although an important crop before 1860, cotton became still more important after the war, the acreage being only limited by the labor to be had or the ability of the planters to cultivate and gather the crop. The subsistence crops were subordinated and thus, as in many other sections, the one-crop system became the almost universal practice. By 1880 the production of cotton had nearly reached its former proportions, and by 1890 the acreage slightly exceeded that of corn. In the next decade there was an increased acreage of both corn and cotton, the increase in the former being about 10,000 acres, making a total acreage in 1900 of approximately 48,000 acres, while the acreage in cotton exceeded that of corn by 12,000 acres, the total being 60,781 acres, which produced 21,563 bales of 500 pounds each. The acreage now in cotton probably greatly exceeds that reported for 1900. Next to cotton and corn in importance is the oat crop, which is grown on most farms and is cut green, cured, and fed as hay. The wheat crop is limited to the northern part of the county. According to the census the average yields are low, but large yields are reported in some instances—as high as 45 bushels per acre being claimed. The acreage in rye should be greatly increased, since it is an excellent winter cover crop and affords forage in early spring. Aside from the oat crop, some grasses and other forage crops are cut for hay. Some Johnson grass is gathered, and gives from three to five cuttings in a season, yielding as high as 5 tons to the acre. It is a nutritious hay and stock eat it readily. Though it makes large yields and brings good prices in the market, it is considered by many as an objection-

able crop. Where it is grown it is the usual intention of the planter to keep the field for that purpose and no other. It makes a good pasture grass, provided the fields are plowed up every two or three seasons, so as to start new growth, as it becomes "sod bound" if left longer.

Bermuda grass is common, but no extensive areas are devoted to it. Broomsedge is to be seen everywhere, springing up in the old fields and open woodland. Millet, Hungarian grasses, and field peas are grown to some extent and some cowpea hay is made. This last crop should receive more attention. It is the most certain to yield well, gives a fine forage, and has a beneficial effect on the soil. Irish and sweet potatoes are produced on small areas on each farm. The former are not as generally grown as the latter, and their production is limited to home needs. Potatoes succeed best on the stony silty to fine sandy soils.

Sorghum is grown in patches on nearly all the farms. Besides supplying the family with sirup, it is a valuable forage crop and should be more extensively grown. Of the tree fruits, peaches receive the most attention. There is a number of small commercial orchards, which yield the growers fair profits in fruit years. They succeed well on the stony upland soils and the fruit is of good quality. The Elberta is the favorite variety. Some apples are grown, but receive no care and do not succeed well. It is probable that they would do well, too, in some of the higher locations, if suitable varieties were planted and proper care were given them. A few pears are produced. Of the small fruits, the blackberry is locally the most important, the wild ones being common everywhere. Huckleberries are also common in the woods on the higher situations. Strawberries are not grown extensively. The supply is hardly sufficient to supply the demand and more should be grown, since they can be profitably produced and meet with a ready sale.

The value of the live stock on the farms is a little in excess of that reported in 1860. The farmer as a rule keeps one or two cows to supply milk and butter for family use. The animals with but few exceptions are the ordinary grades. Cows with some Jersey blood are in favor. The work stock consists of horses, mules, and oxen. The mule is by far the most important and the most satisfactory. Oxen are in common use, both in the woods and on the farms. They are owned mainly by negro farmers.

Until a few years ago the product of the forest was of great importance for a considerable period. It was to get out the timber that the first railroads were built, and lumbering operations on a large scale followed. Particularly important were the longleaf pine forests, but at the present time there is a comparatively small amount of any kind of merchantable timber in the county. There is, how-

ever, a large area in second growth which will in time become valuable, and much land in the county should never be devoted to anything else but forestry.

It is recognized that the lighter silty and sandy soils of the uplands are better adapted to cotton, producing a better fiber, which is less liable to damage by stain than on the heavy red soils. Corn succeeds better in lower situations, as in bottom lands. On farms containing both bottom land and upland, the former is used exclusively for corn and the latter for cotton. Therefore, a rotation of crops is not practiced, the productiveness of the land being kept up by fertilization. There is said to have been a marked improvement in cultural methods in the last few years, due to the introduction of the two-horse turning plow and the disk plow, the latter being generally favored on the heavy red valley lands. The disk harrow, as well as the common peg-toothed or smoothing harrow, is used to some extent; and the two-horse sulky cultivator and the single-horse cultivator having a number of teeth are also coming into use. The small tenant farmers use an improved one-horse turning plow, and this is used also to make the beds for cotton. The plowing is shallow, and this holds true even for the larger turning and disk plows, but though it is shallow, there is at least fairly thorough surface preparation. The practice formerly was, and to some extent is yet, to make the cotton bed while plowing, turning the old row over into the furrow and the next season back again, alternating thus year after year. The better practice, which is followed by many, particularly on the heavy valley soil, is to plow the land during the winter and harrow it, and then just before planting time to make the beds, thus giving the land two workings. Where oats or wheat are to be sown the surface is put into as good condition as possible, using the disk and smoothing harrows. The grain is sown broadcast and harrowed in. In planting cotton a furrow is broken out in the top of the bed, and the fertilizer is put in, generally hand dropped through a long tin funnel, fertilizer distributors not being common. The seed is then sown by a planter, which covers the fertilizer with a little soil upon which the seed drops, and is covered by a board dragging behind, smoothing the surface of the bed. Cotton is given two hoeings, in both of which thinning is done, and is cultivated several times, the number depending on the conditions. The idea is to keep cotton fields clear of weeds. Corn is not given so many workings. The tendency is toward level cultivation rather than the continuance of hilling up or ridging. A practice to be commended, and one which is general, is that of following the contour of the slope in cultivation in order to minimize or prevent washing. Hillside ditches are also employed and some terracing has been done with the same end in view.

The use of commercial fertilizers is general throughout the county. The Twelfth Census shows that in 1899 the expenditure for fertilizers was \$63,490, and that amount no doubt has been annually exceeded since that time. In general only small quantities per acre are used and the fertilizers are generally of low grade, although there is a present tendency to use better grades. The cotton crop is with rare exception always fertilized, the usual application being from 150 to 200 pounds to the acre. For corn very little fertilizer is used. It is usually applied after the plants are well started rather than at planting time, the object being to hasten maturity. Some fertilizer is used with wheat, but practically none with oats. Generally oats are grown on the poorest fields, but it is said in good seasons fair crops are made without the use of fertilizers.

One planter has found that by turning under a crop of cowpeas and using moderate amounts of fertilizer he can obtain a yield of 65 bushels of oats to the acre, and that following this plan another season still further increases the yields. It is generally recognized that cowpeas greatly benefit the soils. With but few exceptions no efforts are made to make and save barnyard manure, though its use always brings good crops. Lime would also prove beneficial, on the heavier soils particularly, but it is not used. It is claimed that the soils are deficient in phosphorus and therefore the fertilizers used are phosphatic. The proportion of potash in the fertilizers is low and is supplied mostly from kainit.

Dependence is placed almost entirely on negro labor to carry on the farming operations. Very little farm help is hired, men having families prefer becoming tenants and making what they can. The negro women and children are used in the fields in hoeing and particularly in picking cotton, being paid in the latter case by the quantity picked. On the whole, the labor, while not in all cases as efficient and reliable as could be wished, still understands the cultivation of cotton and enables the planter to make a good profit when prices are normal. The farmer who hires labor must pay nearly as much as is given on public works, though an allowance is made because board or rations are usually included. Work on the railroad has made a temporary demand for unskilled laborers and the current wages have increased somewhat on this account.

According to the Twelfth Census there are nearly 300,000 acres in farms in the county, about one-half of which is improved. The average size of the farms is given as 72.4 acres.^a The range in size of farms varies greatly. There are many of several hundred acres. Most of the farms owned by white planters range from 100 to 400 acres. Of the total number of farms in the county only 28.6 per cent

^a This is too low, as each tenancy is classed by the census as a separate farm.

are operated by the owners, or, in other words, nearly three-fourths of the farms are operated by tenants.

There are three principal kinds of tenancy, differing mainly in the method of paying the rent. Under one system a cash rent is exacted, under another a fixed quantity of cotton, and under the last a certain proportion of the crop, whatever it may yield. In the first two instances the tenant furnishes everything but the land, in the last the landlord frequently furnishes everything except half the fertilizer and half the seed, in which case the crop is divided equally. In any case there are variations in the contract, dependent upon the productiveness of the land and the ability of the tenant.

The cash rent ranges from \$2 to \$3 an acre; the "standing" in cotton from 1 bale to 2 bales for each unit of 25 acres (one-horse farm). The average is about $1\frac{1}{2}$ bales, and with the ruling prices of cotton this equals a cash rental of \$2 to \$4 an acre, which, on a valuation of \$15 an acre, a fair average for the county as a whole, is certainly a good rate of interest on the investment.

Usually the tenant is at liberty to plant what crops he chooses as long as the acreage of cotton is sufficient to guarantee the rent. Fifteen acres of cotton is the general rule, the remainder of the area being mainly used for corn. The average tenant will secure from the 15 acres from 4 to 10 bales of cotton; the average per acre yield in 1899, according to the census of 1900, was one-third bale.

The value of farm lands varies widely over the county. The rough, hilly, stony lands range as low as \$1 an acre, and there is much land still belonging to the State that can be entered for a merely nominal price. The better valley farms bring as high as \$40 an acre, depending upon nearness to town and character of improvements. Leaving out the extremely rough or undesirable lands, the average value of farming land is probably \$10 to \$15 an acre.

With the prevailing high prices of cotton and other farm products the conditions within the county are prosperous and improving. The wages of labor have increased, but even with this added expense the last few years of good prices have enabled many of the planters to clear up debts and accumulate a surplus. More improvements in general are being made on the farms. More attention is being given to the selection of seed for planting, particularly cotton, thereby increasing the yields and quality of crops. There is also more attention being paid to the use of better fertilizers and, as has already been stated, to the improvement in cultural methods through the introduction of modern farm implements. The improvement of live stock is also receiving attention. Though there has been and continues to be a tendency to general improvement of the existing conditions, there is, however, room for initiative in broader and more fundamental

questions, with a consequent betterment of the conditions as a whole. The present one-crop system of farming is admittedly not the best for the soil, nor is it defensible economically.

A diversity of farm products makes the farmer more independent of price fluctuations and renders his income more certain from year to year. Diversification is also desirable from the standpoint of maintaining the productive power of the soils at the least possible outlay, through the practice of suitable crop rotations. With its mild climate and variety of soils the county could produce a wide range of crops, and all the crops that can be grown and marketed at a profit should be produced on most of the farms of the county. Among the crops grown, those that have a particularly beneficial effect on the soils—the legumes, such as cowpeas, vetch, and clover—should find an important place. Cowpeas do well, and not only improve the soil but give a hay that has a high feeding value. The peas themselves also bring high prices at the present time, and would materially increase the income from this crop. A cereal crop should also be included in crop rotation. Oats and rye are successfully produced. There should also be a grass crop and along with it an increase in the number of live stock, although forage and hay at the present ruling prices would be remunerative and in many cases even more profitable than cotton, considering the fact that they could be produced at less cost. Orchard grass is a valuable hay crop, and does particularly well in moist situations. It could be made to give good yields upon all the heavy valley soils, with good preparation of the soil before planting. The few meadows of Johnson grass have, when properly handled, proved profitable to the growers.

By keeping more live stock and utilizing the barnyard manure the soils could be brought up to a better condition, and at the same time the expenditures for commercial fertilizers reduced. Aside from general farming there is probably no better opportunity than the development of dairying, a class of farming which is very little practiced in the State. The production of beef and the grazing of sheep and goats, the last two on the rougher mountainous lands, could in all probability be made profitable ventures.

Forestry might well be taken up in the case of second-growth land, or even upon lands requiring replanting. A great deal of land that should never be utilized for anything else would be especially suited to the longleaf pine, the lumber from which is steadily increasing in value.

On the whole the outlook for the farming class in this area is encouraging. The mineral resources of northern Alabama are being rapidly developed; the nonagricultural population is increasing, and there is bound to be an increasing demand for all farm products from

the farming sections; and Talladega County, in addition to producing a share of the country's cotton, being close to this region, must be more and more benefited by meeting a part of this demand.

SOILS.

The soils of Talladega County are intimately associated with the underlying rocks, as they have been derived wholly or in part from them. As there is a great variety and diversity in the geological formation, so there is a corresponding variety and diversity of soils. There are two main groups of rocks represented. One group is composed of old metamorphic rocks, extending in a belt from 3 to 8 miles wide along the eastern boundary of the county and known as the metamorphic belt. The second consists of folded sedimentary rocks of more recent origin, which form the remainder of the county, including the Coosa Valley region.

The metamorphic belt of rocks consists of hydro-mica to imperfectly crystalline slates of greenish color, with interbedded sandstones, conglomerates, quartzites, and veins and lenses of quartz. These give rise to three soil types. In the western part of the belt the rocks are more shaly and slaty, and the resultant soil is silty and has a greasy feel, due to the small smooth flakes of the weathered rock. There also remain larger slabby pieces on the surface, with occasional areas covered by quartz fragments. In the eastern and southern parts of the belt the formation becomes more siliceous and here gives rise to a distinct soil type, the top soil being generally sandy, with a large proportion of quartz and other rock fragments on the surface. In this region occasional ledges of the weathered slate are exposed. In the vicinity of Chandler Springs a stony loam type is developed. There the rock approaches a serpentine, to which no doubt is due its unproductiveness. The mountainous ridge in the formation is so steep and stony as to come under the miscellaneous class known as Rough stony land. The topography in general of these soils is so rough and stony that as farming lands they are undesirable, and consequently only a small area is under cultivation, the region remaining practically a wilderness. The best use of such lands would be systematic forestry.

The sedimentary rocks of the Coosa Valley consist of a great variety of limestones, shales, and sandstones, and their metamorphic forms, slates, quartzite, and marble, the most important being the limestone formation known geologically as the Knox dolomite. It has a wide range, varying from a pure limestone, more or less magnesian, to a cherty siliceous limestone. The lower member of this formation—the purer part—has given rise to three types of soil, all in the Decatur series, the principal one being the red clay loam. In

this soil weathering has gone on to great depths and stones or rock outcrops rarely occur. This type of soil, which has been mapped as the Decatur clay loam, forms the most productive and most desirable land in the county. The other two types, the Decatur loam and Decatur stony loam, appear to have a surface deposit of sedimentary origin over the residual subsoil. That they have been covered by water at some past time is evidenced by the rounded waterworn gravel found on the surface and in the soil. In some localities, however, the surface material may be residual, in whole or in part from interbedded sandstones in the dolomite, and it is possible that the gravel has been left from the breaking down of a conglomerate which formerly overlay the dolomite. In some localities, too, close to mountains, the surface may be material washed from the slopes. These soils are all highly ferruginous, as evidenced by the dark-red color and the presence of iron bodies in many places of sufficient extent to be mined. These soils are similar to soils already found in other sections in north Alabama and in Tennessee.

The cherty and siliceous members of the Knox dolomite formation give rise to soils of lower productivity, rougher topography, and more stony character. The processes of weathering in these rocks have been similar to those breaking down the purer limestones, that is, chemical processes, through the solution of the carbonates of lime and magnesia in water charged with carbon dioxide. Besides Rough stony land the residual material gives rise to three types, all of which belong to the Clarksville series. The principal type is the Clarksville stony loam, showing the typical surface accumulation of chert and siliceous fragments of the limestone. The Clarksville loam also occurs and is a soil similar to the foregoing, except in the less quantity of stony material present. The other variation is similar to that found in the purer limestone, and consists of the presence of gravelly material, evidencing the action of water during some stage in the process of soil formation. These are all less desirable soils than the Decatur types, although they produce good crops of cotton. Excepting the gravelly type, which has not been mapped heretofore, the soils are similar to those found on the Highland Rim of Tennessee and in the Ozark Plateau of Missouri. They are locally known as "piney-woods land."

In the depressions and sinkholes throughout the Coosa Valley section occurs a gray or drab silty soil. The material is free from stones and the wash from the surrounding slopes. It is popularly called "craw-fish land," but is shown on the accompanying map as the Guthrie silt loam.

From the shales, with the beds of interstratified sandstones or shaly sandstones, have been derived two types of soil. The one is a silt loam and quite free of rock fragments; the other, occurring where

sandstone predominates, is more sandy and stony. The material is more or less siliceous and the soil is not naturally as productive as the limestone soils. Flat areas of the silty soil are popularly known as "Flatwoods." The silty soil belongs properly in the Dekalb series as Dekalb silt loam, which has been mapped in widely separated localities in earlier surveys, while the thin, stony and siliceous type has been given a local name, Montevallo stony loam, identifying it with the Montevallo shale formation.

In addition to these residual soils, which cover by far the greater part of the county, there are two alluvial soils found along the Coosa River and the smaller streams. One of these types—the Cumberland fine sandy loam—represents sediments laid down by the river at an earlier stage, the terraces it occupies being now above overflow. The sediments are underlain by the residual material derived from limestone. The other type—the Huntington silt loam—is a strictly bottom-land development, and though variable in composition is most often a silt loam.

The name and actual and relative extent of each of the types mapped are given in the following table. The distribution of the soils is shown by color on the accompanying map.

Areas of different soils.

Soil.	Acres.	Percent.	Soil.	Acres.	Percent.
Talladega slate loam	96,562	19.9	Clarksville gravelly sandy loam	5,376	1.1
Decatur stony loam	85,696	17.9	Cumberland fine sandy loam ..	4,864	1.0
Clarksville stony loam	82,560	17.2	Lickdale stony loam	4,416	.9
Decatur clay loam	56,064	11.7	Montevallo stony loam	4,032	.8
Huntington silt loam	39,424	8.2	Chandler stony loam	1,664	.3
Rough stony land	35,072	7.3	Guthrie silt loam	320	.1
Decatur loam	25,664	5.3	Total	479,808	.....
Dekalb silt loam	17,280	3.6			
Talladega stony loam	15,552	3.3			
Clarksville loam	6,272	1.4			

DECATUR CLAY LOAM.

The soil of the Decatur clay loam, locally known as "red land," varies from a dark reddish-brown heavy sticky loam to clay loam and, where washing has occurred, to stiff red clay, the latter being really the exposed subsoil. The average depth of the soil is about 6 inches, but often it is less. In places the surface covering in virgin areas may be more loamy or even slightly sandy, though the covering is so shallow that upon plowing the heavier material from below is turned up, resulting in the heavy soil described. In places, as where the material is added to by washing or little or no erosion takes place, the soil becomes nearly black and of such a peculiar consistency that it does not scour well on the plow and is locally known as "push land."

The subsoil is uniformly a heavy dark-red clay, soft, sticky, and plastic when wet, but very hard and refractory when dry. There is, however, this exception, that in the lower lying areas where the surface is more loamy, the immediate subsoil grades through clay loam into the clay. The depth of the subsoil exceeds 36 inches. In cuts it has been observed to have a depth of 50 feet, and how much farther down weathering has extended is not known. There are occasionally some stones on the surface, particularly chunks of iron-bearing rock or ore, and in the latter case the quantity sometimes becomes quite large. Boulders of limestone are occasionally found in the subsoil, but rarely are outcrops seen, and then only along stream channels.

The Decatur clay loam is the heaviest soil in the county and requires careful handling, for if plowed when too wet it forms clods, which resist breaking down until after they have gone through a winter season. On the other hand, when dry it is very difficult to plow. The disk plow has been found to be most suitable for use on this land, as with the turning plow it does not scour or turn very well.

The Decatur clay loam is found in disconnected areas in all parts of the county. The largest areas are in the valley of Choccolocco Creek and in the Talladega Valley. All the areas are confined to valleys, of which it forms the floors. The surface of the central trough is gently undulating, but the sides rise in hills from 100 to 200 feet higher than the lower part of the valley. The hill slopes are as a rule gentle, and the land is all tillable. This in part accounts for its desirability as farming land, but it washes easily, and when proper attention is not given to cultivating the slopes great gullies are soon eroded.

The surface drainage of the Decatur clay loam is good, but the close character of the subsoil does not allow the ready percolation of water downward. The soil, on account of its shallowness and apparently low water-retaining power, dries out quickly even in ordinary dry weather, the surface baking hard and crops suffering from lack of moisture. Given a rain, the recuperative power of the soil is great and crops soon renew their growth. Some large springs occur in the formation. On reaching the main valley the large streams of the area flow throughout the year. The minor streams through the areas of this soil are small and dry up during the summer, except where fed by strong perennial springs. The water-holding capacity of the soil could be increased by deeper plowing, by subsoiling, and by the addition of organic matter, either as green manure or barnyard manure, or preferably both.

The Decatur clay loam is of residual origin, having been formed through the weathering of limestone and marble. The rock formation is known geologically as the Knox dolomite, which was deposited during the Silurian period. This is a magnesian limestone and the

formation itself is variable. The part that has given rise to the Decatur clay loam consists of the purer, less siliceous and less cherty strata. The solubility of the rock is great, and to form such a deep soil mass has required the solution of a great amount of the original rock. The weathering has been nearly complete as to surface exposures, for rarely are outcrops or even boulders of the original rock found in the soil. There apparently is a relatively large proportion of iron compounds left in the weathering, to the oxidation of which is due the deep red color of the soil mass. Pockets of iron ore consisting of limonite and red hematite occur and have been mined to a considerable extent. The limestone affords stone for building purposes and has been used for fluxing of iron ores, but it seems to contain too much magnesia to be suitable for lime. The marble quarried is of high commercial value for building and other purposes.

The Decatur clay loam is the most productive and durable soil in the county. Originally forested with a heavy growth of deciduous trees, it is practically all cleared and most of it has been under cultivation for a long time. All the crops of the county are produced upon it and give the largest yields obtained. It is expected to produce on the average fully one-half bale of cotton to the acre, though it makes much higher yields where better methods are used. One objection, however, is that the crop is damaged by staining when dashing rain occurs. Corn usually does well. The average yield is about 25 or 30 bushels per acre, though double or treble this quantity has been secured in several instances. When wheat was grown quite generally throughout this county the highest yields were reported on the Decatur clay loam, as high as 45 bushels per acre being reported. Occasionally these large yields are now obtained, and with ordinary seasons it is expected to produce from 15 to 25 bushels. It is a soil well adapted to growing cereals and grasses. All grass and forage crops make large yields, Johnson grass yielding as high as 5 or 6 tons of hay per acre in four to six cuttings. Orchard grass also makes large yields, especially on lower lying situations, where better moisture conditions prevail. Bermuda grass succeeds, as will also the leguminous crops, cowpeas, vetch, and clovers. The first mentioned does particularly well and should be more extensively grown.

Farms on this type would be especially well adapted to dairying and stock raising, and it is believed would prove more profitable if used for general farming, including stock, than under the present one-crop system of producing cotton. On this soil, as well as all others of the county, no systematic rotation is followed, the main crop being cotton. Better cultural methods, however, are employed on the Decatur clay loam than on the lighter soils, and the example is having an influence in improving the agricultural practices generally. Many fine farm dwellings are seen on the Decatur clay loam, also good outbuildings

and well-fenced fields. The value of the farms ranges from \$10 to \$35 or more an acre.

The average results of mechanical analyses of typical samples of the soil and subsoil of the Decatur clay loam are shown in the appended table.

Mechanical analyses of Decatur clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16327, 16477.....	Soil.....	1.4	5.7	3.7	11.1	9.0	38.1	31.3
16328, 16478.....	Subsoil.....	.9	3.2	2.2	5.9	4.8	30.1	52.1

DECATUR STONY LOAM.

The surface soil of the Decatur stony loam varies from a dark-brown silty loam or loam to a medium to fine sandy loam. The soil is generally shallow, averaging not over 6 inches, and only in rare instances exceeds a depth of 10 inches. The subsoil is for the greater part a dark-red heavy clay loam grading quickly into stiff, plastic dark-red clay, the material being the same, or practically the same, as that underlying the Decatur clay loam. In some places, however, the subsoil is of yellowish-red color, and sometimes has a more or less greasy feel where shales have entered into its formation. Upon the surface and in the soil are always found some stones, the quantity varying from 10 per cent to conditions where the surface is completely covered and only a small proportion of interstitial material is found. The stones consist for the most part of subangular and rounded sandstone fragments, varying in size from small gravel to pieces several inches in diameter. There is also more or less quartz and quartzite present, and in places slabs of siliceous limestone.

Occasionally some chert is found, and in this case the type approaches in character the Clarksville stony loam, which is derived from siliceous and cherty limestones. Some stones are found in the subsoil, but usually in veins or strata. They consist of siliceous limestones of a chalky appearance, shaly sandstones and shales, and in areas next to the mountains the subsoil includes stones interstratified with the fine-earth material and evidently largely wash from the mountains. This type in some localities includes areas in which the soil is more clayey and of reddish or reddish-brown color, but which are so stony and of so little importance agriculturally that they could be classed with it.

The Decatur stony loam is extensively developed in all parts of the county. It occupies the lower slopes of the mountains and the low foothills and the tops and slopes of valley ridges. For the most part, especially in the larger areas, the topography is rather hilly and

rough. This character of surface insures good drainage. The loamy soil with the stones strewn over the surface is favorable to the retention of moisture, and crops do not suffer so much from drought as on the heavier limestone valley soils.

The material forming this soil type is probably derived from two sources. The subsoil is residual, representing mainly the detritus from the purer strata of the Knox dolomite, although shales may have also to some extent been a factor in its formation. The surface soil appears to be transported material, for the most part a wash or talus from the mountain slopes spread over the residual material. On the valley ridges the soil may be residual in part, derived from strata of sandstone in the original limestone beds, but even in this case it seems evident that the material has been reworked in water, the stone and gravel being more or less grounded. All the crops grown in the county are found on this soil type. Excepting the rougher and more stony areas, it is held in high esteem because of its friable character, resistance to drought, and general productiveness. It is well adapted to cotton and corn. Cotton yields as much as 1 bale per acre, and corn gives as good yields as are obtained from any of the upland soils. It is well adapted to fruit growing, and the commercial peach orchards of the county are found upon it. Apples also do well, as do the different kinds of berries.

The tree growth is mostly deciduous, black jack and white oak being prominent species. There is also some pine. The value of the land averages about \$10 an acre, but nearer towns it brings much better prices. On the whole it rents for practically as much as the heavier limestone valley lands, because of its adaptation to cotton and corn.

The average results of mechanical analyses of samples of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Decatur stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16513, 16469.....	Soil.....	3.1	8.9	5.7	13.4	4.9	44.1	19.6
16514, 16470.....	Subsoil.....	1.5	5.1	2.4	6.4	2.1	38.0	44.5

DECATUR LOAM.

The soil of the Decatur loam varies from a brown, silty, heavy fine sandy loam to a dark-brown friable loam. Analyses show that the soil contains all grades of material, the silt predominating and in some cases comprising more than 50 per cent of the soil mass. The soil ranges in depth from 4 to 10 inches, the average being about

6 inches. In most areas it is shallow enough to allow the subsoil to be turned up in plowing, and the plowed fields have a spotted appearance due to this cause. When dry the soil has a grayish color and a rather ashy character.

The subsoil is generally a bright-red or yellowish-red clay loam or in some cases a dark-red clay loam, grading into stiff, sticky, dark-red clay. The upper few inches of this subsoil usually contains enough sandy material to give it a gritty feel and to make it more friable. Generally the type is free or nearly free from stone, but occasional gravelly areas occur, especially near stream courses.

The Decatur loam is not so generally distributed over the county as the Decatur clay loam and the Decatur stony loam. The largest areas occur along the Coosa River, one in the northern part of the county and another in the central-western part. Other smaller areas are scattered in the northern and southern parts of the county. The surface features consist of low hills with practically no steep slopes, so that all the type is suitable for cultivation. Its position gives good surface drainage and yet the drainage is not rapid enough to make washing a serious problem, as in the case of some of the other soils. It is not a droughty soil, the surface favoring the absorption of the rainfall and the close subsoil its retention. It also shows lasting effects from the fertilizers applied to it, a characteristic of all the limestone soils with clay subsoils.

Like the Decatur stony loam, the Decatur loam is without doubt derived from two sources and may be considered the stone-free phase of the former type, the subsoil being residual from limestone and the soil evidently a sedimentary deposit reworked by water and spread over the residual limestone material. There are exceptional areas, however, where the surface soil is probably the result of wash from mountain slopes, and some where both soil and subsoil are residual in places, the top soil being derived either from fine-grained sandstone beds or from the more siliceous layers of the limestone itself.

The Decatur loam is adapted to the growing of cotton and corn, making average yields that compare favorably with the best in the county. This soil should also be admirably adapted to small fruits, to the tree fruits, and to truck gardening, particularly the heavy truck crops, such as Irish and sweet potatoes.

The natural vegetation consists of mixed forests of pine and hardwood species of trees, but land of this type is largely cleared and under cultivation. The value of such land ranges from \$10 to \$20 an acre.

The average results of mechanical analyses of the soil and subsoil of the Decatur loam are given in the table following.

Mechanical analyses of Decatur loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16240, 16473.....	Soil.....	0.3	6.7	7.4	19.9	10.8	45.8	9.2
16241, 16474.....	Subsoil.....	.3	3.3	4.2	11.2	6.5	44.2	29.9

CUMBERLAND FINE SANDY LOAM.

The soil of the Cumberland fine sandy loam consists of a light-brown to yellowish or grayish silty fine sandy loam, with a depth varying from 8 to 15 inches and averaging 12 inches. The surface soil is underlain by a thin layer of yellowish-red to red gritty clay or clay loam, which changes quickly into a dark-red stiff clay. Occasionally some rounded gravel occurs on the surface and in the soil.

This type of soil occupies only a small area in the county, occurring in the bends of the Coosa River and along Choccolocco Creek. It occupies rolling and sloping terraces and excepting the lower-lying portions is above high-water mark. Included with the areas of this soil is a narrow band, not exceeding a few rods in width, forming a natural levee along this river and consisting of fine sand to a depth of several feet. This strip is subject to overflow and is so narrow that it was not practicable to make it a separate type of soil on the map.

The drainage of the Cumberland fine sandy loam is excellent though not excessive. As in case of the Decatur stony loam and Decatur loam, the Cumberland fine sandy loam is residual in the lower and sedimentary in the upper part of the profile. The subsoil is derived from limestone weathered in place, while the soil is evidently a deposit of the river when it flowed at a higher level than now. The light sandy character of the surface soil makes this type very easy to cultivate. The subsoil is retentive of moisture, enabling crops to withstand droughts. It gives average yields of the crops grown, to all of which it is well adapted. It would also be an excellent soil for strawberries and other small fruits. It is all cleared and under cultivation.

The results of mechanical analyses of typical samples of soil and subsoil are given in the following table:

Mechanical analyses of Cumberland fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16157.....	Soil.....	0.6	2.2	4.6	36.5	29.4	20.1	6.5
16158.....	Subsoil.....	.4	1.2	3.0	20.6	8.3	44.8	21.4

CLARKSVILLE STONY LOAM.

A profile section of the Clarksville stony loam shows 6 to 12 inches, with an average of 8 inches, of fine-textured ashy silt loam or silty fine sandy loam, with which is mingled cherty and siliceous rock fragments. The color of the surface soil for a few inches is gray, drab, or sometimes light brown, changing to a light yellow. When dry the surface has a whitish appearance and an ashy feel and the land is called generally "white land" or "gray gravelly land," though another term, "piney-woods land," is also in common use. The rock material, which is concentrated in the surface foot, consists of angular fragments ranging in size from fine gravel to blocks a foot or more in diameter, though the average diameter of the larger stones is from 3 to 6 inches. These occur in the soil and upon the surface, the quantity varying considerably, say from about 15 per cent of the soil to a mass of rock fragments without interstitial material, the latter condition occurring on the tops of hills and narrow ridges.

The subsoil, which varies but little throughout the extent of the formation, consists of a yellow heavy silt loam to clay loam, changing with depth to reddish yellow and then to yellowish red and grading at a depth of 30 inches or more into a red silty clay. Very few cherty fragments are found, though occasionally bands of weathered and broken siliceous limestone occur. For the most part the subsoil is free from stone, and except on tops of hills and ridges very deep.

The Clarksville stony loam is one of the extensive soil types of the Coosa valley portion of the county, the largest areas being along the Coosa River from Choccolocco Creek to the vicinity of Childersburg; at these points its continuity is broken. Scattered areas occur in other parts of the valley region. It occupies the valley ridges and hills and in most cases the topography is rough. The broad areas along the Coosa River appear to be a much dissected plateau, having irregular ridges with narrow tops and sides sloping steeply to narrow valleys lying from 100 to 300 feet below. The streams in the smaller of these valleys are intermittent.

The topography of the Clarksville stony loam causes rapid surface drainage. In fact the soil, because of its surface features, stony character, texture, and open structure, is apt to be droughty. Even in ordinary dry spells crops suffer greatly for moisture, the soil having low water-holding power. When very wet the soil in cultivated fields becomes like mortar. This soon dries and forms a crust, which, however, breaks up readily upon cultivation.

The Clarksville stony loam is of residual origin, being derived through weathering from the cherty and siliceous limestones known as the Knox dolomite and of Cambro-Silurian age. This is a variable formation, ranging from practically pure limestone or dolomite in its lower part to siliceous limestone with cherty layers, this latter phase

giving rise to the type under discussion. The process of breaking down in the rock has been largely by the solution of the lime and magnesium carbonates in meteoric water charged with carbon dioxide. The less soluble residue has been concentrated for the most part on the surface as a mass of angular gravel, stones, and silty material. The weathered fragments of chert are mainly white, though some, particularly the larger blocks locally called hornstone, are dark-colored. The formation is highly magnesian and to this is believed to be due in part the low productiveness of the soil.

The Clarksville stony loam is considered one of the poorest soils of the county and with its rough topography, large stone content, and droughty condition is not desirable as farming land. But a small proportion of it is cleared and cultivated and the cleared areas are only found in the better parts. It is said, however, to do fairly well for cotton, the quality being good. It requires heavy fertilization at present to produce any crops. The soil is lacking in organic matter and no doubt if managed in such a way as to increase this constituent could be made much more productive. On lower slopes, where better moisture conditions prevail, fairly good crops of corn are produced.

This soil would probably prove very well adapted to fruit culture, if proper care were given to the trees and to fertilization. On a similar soil in more northern localities, in Missouri, for instance, fruit growing has proven profitable.

The typical forest growth on this soil is the longleaf pine and because of this the land has become known generally as "piney-woods land." In the extremely cherty areas the black-jack oak flourishes. Because of its poor yields, as compared with other soils, the value of the Clarksville stony loam is low. The land is worth more as a source of pine than for any other product except for occasional deposits of iron ore, and should be devoted to systematic forestry.

The average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Clarksville stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16155, 16461	Soil	4.0	6.8	4.9	11.6	9.0	51.2	12.8
16156, 16462	Subsoil	1.9	4.0	3.1	8.5	5.3	48.8	28.6

CLARKSVILLE GRAVELLY SANDY LOAM.

The soil of the Clarksville gravelly sandy loam consists of a light-brown, grayish, or yellowish medium to fine sandy loam, with an average depth of 8 inches, and carrying a large percentage of fine and coarse rounded quartz, sandstone, and chert gravel. The finer

material has an ashy feel, which is due to the relatively large proportion of silt which it contains. The subsoil is a gritty or sandy yellow clay loam, changing into yellowish red and grading into clay which is very stiff in the lower depths. It contains some small sharp fragments, and these impart a gritty feel. It is an easy soil to cultivate; the gravel, though often completely covering the surface, does not seem to interfere much with farming operations. In appearance and in the way the soil acts under cultivation it is much like the Clarksville stony loam and is known locally by a similar name, "gray gravelly sandy land."

This type of soil is not extensively developed in the county, occurring only in comparatively small areas, generally near stream courses. It occupies hilly areas, but the slopes are not steep and can all be cultivated. This character of surface insures good drainage, and in this respect the type is much like the Clarksville stony loam. It is droughty and deficient in organic matter.

This type is not entirely of residual origin. Evidently the soil at least has been reworked by water in the past, and from the presence of rounded sandstone gravel some of the material must have been transported. The subsoil is evidently residual, having been derived from a siliceous member of the limestone or dolomite formation. The subsoil, though, from its gritty character, may have been to some extent influenced by the action of water, the sandy material in it being the result of such action. The Clarksville gravelly sandy loam is a poor type of soil, but in good seasons if properly fertilized makes fair crops of cotton. The natural forest vegetation is like that of the Clarksville stony loam. The longleaf pine with some deciduous trees are found on this type.

The mechanical analyses of a fine-earth sample of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Clarksville gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16457.....	Soil.....	5.4	25.4	12.4	19.1	14.1	17.4	5.6
16458.....	Subsoil.....	4.1	14.7	8.5	12.3	9.9	23.6	26.1

CLARKSVILLE LOAM.

The soil of the Clarksville loam to an average depth of 8 inches varies from a silt loam or silty loam to a silty fine sandy loam, and in places is still somewhat coarser, resembling in texture the fine earth of the Clarksville gravelly sandy loam. It lacks the gravel found in the type just mentioned, but contains some cherty and siliceous limestone and quartz fragments and occasionally a few

larger stones, but never enough to hinder cultivation. Its color is light brown, light yellow, or gray. The surface has a gray appearance and the soil generally a somewhat ashy feel. The subsoil is a heavy yellow silt loam grading into reddish-yellow silty clay loam and this at about 36 inches or less into dark-red silty clay loam or clay. It contains some sandy material, making it usually friable, although in places it becomes more plastic.

The Clarksville loam is confined largely to the valley areas in the northeastern part of the county. It occurs in several large irregular-shaped areas with other smaller scattered bodies. The topography as a rule is gently rolling to hilly. It also occupies the bottoms and lower gentle slopes below the Clarksville stony loam areas. It has good surface and subsurface drainage and like the Clarksville stony loam and Clarksville gravelly sandy loam is somewhat inclined to be droughty.

The Clarksville loam is a residual soil type, derived from siliceous limestone or dolomite, and weathered fragments of the rock together with some chert and quartz are occasionally found in the surface soil. It appears to be a less stony condition of the Clarksville stony loam and like that soil is one of the less productive types, though more desirable than the Clarksville stony loam, because it lacks the high stone content and is more easily cultivated. It produces fairly good yields of cotton. The natural forest growth is longleaf pine, but the most of the type is cleared and under cultivation. Its value is fairly high, the prices ranging from \$10 to \$20 an acre.

The average results of mechanical analyses of typical samples of the soil and subsoil of the Clarksville loam are given in the following table:

Mechanical analyses of Clarksville loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16453, 16455.....	Soil.....	3.9	8.6	7.4	15.2	13.0	43.5	7.9
16454, 16456.....	Subsoil.....	2.0	4.7	4.2	9.5	8.6	48.5	21.8

GUTHRIE SILT LOAM.

This is an unimportant type occurring in small areas in the limestone formation, being found in the depressions or large sinks. It consists of about 8 or 12 inches of gray or drab compact silt loam, underlain by drab to yellow, heavy, compact, silt loam. This soil becomes hard during dry spells and acts much like a clay, yet it is not a clay. It is known as "crawfish land." It is evidently a wash from the surrounding slopes, and from its position is generally wet and poorly drained. During very rainy spells water stands upon

it, and some parts of it are truly swampy. Because of this undrained condition it is of practically no value. The sweet gum is a characteristic growth upon it and the drier areas support longleaf pine.

LICKDALE STONY LOAM.

The Lickdale stony loam consists of a gray to light yellowish ashy silty loam to silty fine sandy loam, with a depth of 6 inches, underlain by yellow silt loam or loam carrying noticeable quantities of fine sand. In some places, however, the subsoil is somewhat heavier and when of reddish color is a silty clay loam. Rarely could the soil auger reach beyond a depth of 24 inches because of stones. These consist of subangular fragments, from small, gravelly particles to large stones, and are found both on the surface and throughout the soil profile. The quantity is often sufficient to interfere materially with cultivation. In fact in some areas they completely cover the surface.

There are only two areas of the Lickdale stony loam shown on the map, a narrow strip occurring on the lower northwest slope of the Talladega hills, extending their whole length, and the other occurring on the slopes of a small mountain in the south-central part of the county near Weewokaville. The Lickdale stony loam is formed entirely from the débris or talus from the mountains spread over the other formations. The material is several feet deep and not influenced by the underlying rock formation.

Occurring as it does in the mountain slopes the drainage of the type is excellent, but the texture of the soil is such that it is not retentive of moisture or fertilizers and is droughty, and with its stony nature is of very little agricultural value. It is not under cultivation, but is covered by a light growth of pine and oak, with an undergrowth of huckleberry bushes.

The results of mechanical analyses of a fine-earth sample of the soil and subsoil of the Lickdale stony loam are given in the following table:

Mechanical analyses of Lickdale stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16262.....	Soil.....	2.2	7.2	5.0	12.1	17.0	44.6	11.9
16263.....	Subsoil.....	1.3	4.9	3.9	10.3	14.6	43.7	21.2

DEKALB SILT LOAM.

The soil of the Dekalb silt loam to an average depth of 8 inches consists of a light brown or rather gray ashy-textured silt loam or silty fine sandy loam changing with depth to a light-yellowish color. This material is underlain by a heavy yellow silt loam, which becomes heavier with depth and in places is a silty clay loam or clay. In

some areas the deep subsoil is of a reddish-yellow or even dark-red color, and in such cases is much heavier in texture. The larger part of the type is free from stones, but small areas occur on knolls and hills where are to be found shaly fragments or flakes of argillaceous to sandy shale, and there are small areas which could be classified as a shale loam. Most of the rock in such locations, however, consists of sandy shale and shaly sandstones, the pieces varying in size from small chips to fragments several inches in diameter, the larger ones generally being angular. The Dekalb silt loam for the most part is an easy soil to cultivate, although in the level and wet areas the soil compacts and clods badly.

The Dekalb silt loam occurs in several large, continuous, narrow strips in the Coosa Valley section of the county, the boundaries being rather irregular. It occurs in level, undulating, and knobby or hilly areas, the hills or knobs being rounded—the characteristic topography of the soils derived from shale formations. The entirely flat areas are not extensive, and are locally known as “flatwoods.” They are poorly drained, and for the most part are covered with pine, sweet gum, and other trees. The higher parts of the type are covered by longleaf pine.

The Dekalb silt loam is a residual soil derived from the disintegration of shales—mostly fine-grained and sandy—and shaly sandstones and fine-grained sandstone. In some places possibly siliceous limestone or dolomite may have a part in the formation of this soil. The low, flat areas, too, may be, in part, a wash or sedimentary deposit.

This is a cold soil, particularly in the flat, poorly drained areas, and crops are late in getting started unless the season is particularly favorable for growth. The soil needs more organic matter and is generally considered one of the less desirable soils. Excepting the drier portions, it is not adapted to cotton, but does best with corn. Only small yields of any crop can be expected. There are some small farms on this type. Though classed among the cheap lands of the county, the soil, if properly drained and carefully managed with a view to increasing the content of organic matter, would bring good returns for the labor expended. The value of the land ranges from \$5 to \$10 an acre.

The average results of mechanical analyses of two typical samples of the soil and subsoil of the Dekalb silt loam are given in the following table:

Mechanical analyses of Dekalb silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16311, 16467.....	Soil.....	2.0	3.9	1.7	5.6	5.0	66.1	15.6
16312, 16468.....	Subsoil.....	.7	1.9	1.3	3.8	2.8	61.5	27.4

MONTEVALLO STONY LOAM.

The interstitial material of the soil of the Montevallo stony loam consists of a light brown or gritty gray silt loam, tending in places to the texture of a silty sandy loam or sandy loam. The average depth of the soil is about 5 inches. On some cultivated slopes the soil has been largely removed, and the plow turns up the reddish subsoil, giving the surface a reddish cast and heavier texture. The subsoil consists of a yellow or reddish-yellow greasy silty clay loam, changing to stiff plastic red silty clay. The subsoil usually does not exceed 24 inches in depth and is underlain by a mass of broken rock. The surface of the Montevallo stony loam is, for the most part, covered with rock fragments varying from small shaly chips to blocks of shaly sandstone or sandstone several inches in diameter. On the tops and slopes of the higher, steeper hills the stones are larger, consisting of angular sandstone 3 to 6 inches or more in diameter. The parent rocks outcrop in some places or are at most covered only with a thin mantle of soil, and in cuts along roads and streams the weathered sandy shale and shaly sandstone are frequently exposed.

The topography of this type of soil consists generally of hills with smooth contours and of irregular-shaped ridges with narrow tops and steep slopes. The areas near the Coosa River are extremely broken, while to the east the hills become lower, the slopes less steep, and better suited to cultivation.

The character of the soil and subsoil and the broken condition of the rocks underlying the Montevallo stony loam allow rapid passage of the water downward, yet with heavy rains washing results on the steep and less stony slopes. The small streams forming the minor drainage channels for this soil are intermittent. There are only a few areas of the Montevallo stony loam. The main area occurs in the extreme southwest corner of the county. There is also an area in the northwest and a number of others in the central part. The type is of residual origin, being derived from the degradation of variegated sandy shales, shaly sandstones, sandstone, and probably some limestone of the Montevallo. All rocks are more or less ferruginous, which gives to the subsoil its red color. The greater part of the type is derived from the most recent geological formation in the county, the Upper Subcarboniferous. Some other areas have arisen from the breaking down of the older sedimentary rocks of the valley region correlated with the Cambrian age.

Owing to its steep slopes and stony character, but little of the soil is under cultivation. It is covered for the most part by forest growth, mainly longleaf pine, with a scattering of deciduous trees. The original forest growth was rather heavy. The rougher portions are of no value except for their timber, but on the better portions the

land is fairly productive. It is a much stronger soil than the hilly parts of the Dekalb silt loam.

The average results of mechanical analyses of the fine-earth samples of the Montevallo stony loam are given in the following table:

Mechanical analyses of Montevallo stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16463, 16465	Soil	6.4	6.2	2.3	5.3	31.5	34.4	13.9
16464, 16466	Subsoil	4.3	5.3	1.7	4.1	8.4	44.6	31.8

TALLADEGA SLATE LOAM.

The surface soil of the Talladega slate loam consists merely of a shallow mantle, rarely 6 inches in depth and probably not averaging over 4 inches, of a shaly or slaty dark-gray or light-brown silt loam having a soft greasy or soapy feel. The soil texture, however, is variable, and in some places becomes quite sandy and coarse, but only in narrow streaks following variations in the underlying rock. The subsoil, which rarely exceeds 20 inches in depth, is a uniform slaty dark-red clay loam or clay, having the peculiar greasy feel that is so characteristic of the soil. This textural feature is due to the presence of decomposing hydro-mica slate fragments contained in it. Occasionally the subsoil is yellow and quite sandy, being influenced, as is the soil, by the variation in the rocks from which derived. The parent rock in a fragmentary mass is found at an average depth of 20 inches.

Upon the surface and scattered throughout the soil mass are varying quantities of shaly or slaty fragments in a state of partial decomposition. In places the small flaky fragments may cover the surface and occupy the greater part of the soil mass. Again, where weathering has gone further and less erosion has taken place, these fragments are much less in evidence. There also occur upon the surface large slabby pieces of the slate and fragments of quartz and quartzite, and the amount of rock material is sufficient to give the larger part of the type a stony character. The quantity of quartz and quartzite increases in the eastern part of the metamorphic belt, where in places it becomes sufficient, together with a change in the interstitial material, to form another type of soil.

As stated, the soil covering is shallow, and on cleared hills it has been largely eroded, or being shallow is incorporated into the upper few inches of the subsoil, thus giving rise to a heavier surface material or greasy clay loam and changing the color to grayish red.

The Talladega slate loam is the most extensive soil type in the county. It occurs as a broad belt which in its narrowest place is not less than 3 miles wide and extends in a northeast-southwest direc-

tion along the whole eastern part of the county and a large part of the southern boundary. The topography is rough. The whole belt is really a deeply eroded plateau, the average elevation of which is between 900 and 1,000 feet above sea level; with the higher parts reaching to nearly 1,100 feet and the bottoms of the stream valleys 200 to 300 feet lower. The higher elevations are to the east and north, the upper portion forming the crescent-shaped ridge known as the Kentucky Mountains. From the east the slope is gradual to the west and southwest. Erosion has greatly dissected the plateau, resulting in narrow irregular-shaped ridges, hills, and knobs, apparently without arrangement, and having a uniform elevation and steep slopes, but generally smooth contour, although some precipitous cliffs occur, and the valleys are narrow and V-shaped.

The drainage of the Talladega slate loam area is exceedingly rapid, the seams in the slate allowing the water to pass down readily rather than off the surface, and resulting therefore in numerous creeks and branches which carry water throughout the year. These streams are clear and rapid flowing, and would afford much water power.

The Talladega slate loam is a residual soil, derived from imperfectly crystalline and hydro-mica slates. The soil is the result of the breaking down of these rocks by both chemical and physical agencies. The weathering, however, has not been complete, as shown by the great quantities of small and large fragments still found in the material. The quartz and quartzite in the soil are derived from veins penetrating the slate formation. The former have persisted because of their hardness and great resistance to weathering and have played little or no part in the formation of the soil itself. A feature of the weathered slate is the small pearly flakes left in the soil formation, having a greasy feel and imparting this characteristic to the soil and subsoil.

Because of its rough and stony character, this type of soil is not well adapted to agriculture and but a small part of it is under cultivation. By far the greater part is in forest, consisting of a variety of trees. Of the deciduous species the oak predominates. There is also considerable pine, mostly longleaf pine. The original forests, however, have been largely removed and the timber standing is mostly smaller second growth and of very little present value.

The cultivated areas are mainly confined to the western edge of the belt. An important area lies east of the Blue Ridge Mountains in the vicinity of Chandler Springs. The crops grown are chiefly cotton and corn, but the soil is not well adapted to these crops and large yields are not expected or obtained. It is much better adapted to small grains and grasses. Heavy export tobacco has been tried on this soil and is said to have yielded well. The best use for the type, however,

is forestry, and it should be kept in forest, at least until the demand for land is much greater than at present.

The most of this land is held by a mineral and land corporation, which, after the original timber growth is removed, sells it for from \$1 to \$3 an acre, the latter price being for the more desirable locations and where the second growth is fairly good. In the northern portion of this belt and particularly along the railroads some areas bring as high as \$10 an acre.

The average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Talladega slate loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16246, 16479.....	Soil.....	3.9	6.1	3.9	11.5	5.9	46.0	22.6
16247, 16480.....	Subsoil.....	1.8	4.9	2.8	8.9	4.1	39.4	38.1

TALLADEGA STONY LOAM.

The interstitial soil of the Talladega stony loam consists of a gray, ashy, silty fine sandy loam from 8 to 15 inches in depth, with an average depth of 12 inches, mingled with varying quantities of quartz fragments. Below 5 inches the soil changes to a light yellowish color. Between the soil and subsoil there is a sharp line of demarcation, the latter being, like that of the Talladega slate loam, a dark-red clay loam to clay, having the peculiar greasy feel, though not to quite so pronounced a degree, and carrying stone fragments. The subsoil is friable when dry, and when wet is puttylike, but not sticky. In places the subsoil varies, the upper part becoming yellowish-red in color and somewhat less clayey, but changing to the typical deep-red color lower in the profile. The depth of the subsoil generally exceeds 36 inches. The quartz fragments are found on the surface and in the soil in varying quantities, ranging in size from small gravelly particles to irregular angular blocks several inches in diameter, and the quantity is generally sufficient to make the soil a gravelly or stony type. In the subsoil are to be seen occasionally bands or strata of more or less weathered shale or slate.

The Talladega stony loam is found in the metamorphic belt. It is not an extensive type. The largest unbroken area occurs in the extreme southeastern part of the county. Four other considerable bodies lie about midway of the eastern boundary of the county.

This soil is found on the tops of the broader ridges in the metamorphic belt, but in the large areas it has a topography distinctly its own, consisting of rather high hills of gentle and smooth slope. Here it is all suited to cultivation. Though the drainage is good, the fairly

heavy subsoil tends to conserve moisture, and the type is not so droughty as the ashy nature of the surface soil would lead one to expect.

The Talladega stony loam is of residual origin, derived from the same class of rocks as the Talladega slate loam, with the exception that it occurs in those parts where the sandstone, quartz, and quartzite exist in greater quantities and have had a predominating influence upon the soil, giving it the light silty to fine sandy texture. This is considered a particularly desirable soil for growing cotton, and is devoted largely to that crop, making about the same average yield as the other desirable soils of the county. It is a warm soil and easy to cultivate, and at least a partial crop of cotton is assured even in a very unfavorable season. Corn also does fairly well on this upland soil. The tree fruits would undoubtedly succeed, and strawberries would thrive on the less stony situations. The soil could be greatly improved by growing and turning under leguminous crops occasionally, as it lacks humus matter. Such treatment would make it capable of holding more water and would also increase its productivity in other ways. Considering the location, there is no better crop for this purpose than cowpeas. The native vegetation on this soil was largely longleaf pine, but a good part of the growth has been removed. The soil is held in higher esteem than the other soils of the metamorphic belt, and prices are somewhat higher.

The results of mechanical analyses of a typical sample of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Talladega stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16244.....	Soil.....	7.5	11.6	4.8	7.3	14.9	43.5	10.5
16245.....	Subsoil.....	.8	2.1	1.8	3.7	6.0	31.4	53.4

CHANDLER STONY LOAM.

The soil of the Chandler stony loam is a light-brown, grayish, or yellowish stony silt loam, fine sandy loam, or silty fine sandy loam, 3 to 6 inches in depth, underlain by a yellow compact silt loam or clay loam which becomes heavier with depth. The subsoil does not generally exceed 24 inches in depth, as at that point the more or less broken parent rock is found. The subsoil in some areas has a red color, and this is accompanied usually by a somewhat marked increase in the clay. Sometimes the surface of the fields shows this red tinge where erosion has brought the subsoil within reach of the plow.

Upon the surface and in the soil occur small fragments of the underlying rock. In some places the quantity is sufficient to cover the surface and form the larger part of the mass of the surface soil. There also occur larger slabby pieces of rock and, in places, boulders. The proportion of the larger fragments varies from a small per cent to quantities completely covering the surface and practically precluding cultivation.

The Chandler stony loam occurs in only one area in the eastern part of the county, and that not very large, extending from Chandler Springs in a belt southwest and on out of the county. The topography in the vicinity of Chandler Springs is that of a low ridge, while to the southwest it becomes higher and hilly. The drainage is on the whole good, although small flat areas or glades occur where water stands, the subsoil being more or less impervious in these places.

The Chandler stony loam is a residual soil derived from a metamorphic rock, in the main of a greenish color, schistose structure, and a very fine sandy texture. It breaks into slabs upon weathering, the surface having a slightly smooth feel. Some of the rock, however, appears to have a more crystalline structure, is much harder, and weathers into boulders. This phase is probably nearly a serpentine, and this may account for the poorness of the derived soil.

Its stony character and general low productiveness makes it one of the less desirable soils to cultivate, and in fact very little of it is cleared and under cultivation. It is covered by forest growth, consisting largely of oaks, among which the black-jack oak is prominent. There is also some pine, and the chief value of the land lies in its timber.

The results of mechanical analyses of a fine-earth sample of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Chandler stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16451.....	Soil.....	6.1	6.1	2.5	3.6	5.1	61.7	15.0
16452.....	Subsoil.....	1.8	5.3	3.1	6.5	6.0	53.8	22.7

ROUGH STONY LAND.

The term Rough stony land is applied to those areas too steep and stony for agricultural purposes and fit only for forestry and grazing. The soil, what there is of it, has the character of the formations in which it occurs, i. e., the interstitial material may approximate the fine material of any of the typical stony soils. The areas occupy the tops and upper slopes of the mountains and rougher stony ridges and hills. Their occurrence is due mostly to the presence of sand-

stone, conglomerates, and quartzite strata, which are especially resistant to weathering and have persisted to form the rougher, more prominent topographic features of the region. The most extensive areas of Rough stony land form the Talladega Hills and the Kahatchee and Katala mountains, and the ridges and mountains which probably formerly connected them. The land is at present of no value except for the forest growth. This has, in most instances, been fairly heavy, the principal growth having been longleaf pine.

HUNTINGTON SILT LOAM.

The Huntington silt loam consists of 10 inches of drab to light-brown silt loam, underlain by yellow or brownish-yellowish compact silt loam, which sometimes becomes a silty clay loam, and extends to depths exceeding 36 inches. In places the soil becomes more sandy, owing to the difference in deposits occurring nearest the streams, and in small areas the soil is sometimes brown or even reddish in color, being influenced by wash from the immediate slopes of areas of the red limestone soils.

The Huntington silt loam is an alluvial soil and subject to those minor variations usual in this class of soils. It has been deposited in the present flood plains of the various streams and represents materials from the immediate slopes and those transported long distances during floods, all mingled in complex though variable arrangements. Areas occur scattered over the county along the streams. They vary from a few rods to as much as a mile or more in width, the largest being found in the middle courses of the larger streams.

The Huntington silt loam is the best corn soil of the county, and is largely devoted to that crop. Yields of from 25 to 50 bushels per acre are obtained, and these could be increased by better cultural methods. The type also makes good grass and pasturage land and produces large crops of Johnson grass wherever the grass is allowed to grow. It does not answer so well for cotton. The crops are subject to damage by floods, as all the areas are overflowed during high water. Land of this type has been in cultivation for a long time, but practically no fertilizers are used nor does there appear any necessity for their use at present. These bottom lands are highly prized and as a rule are not on the market.

The average results of mechanical analyses of the soil and subsoil of this type are shown in the following table:

Mechanical analyses of Huntington silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16159, 16242.....	Soil.....	0.1	0.5	0.6	2.2	6.1	70.3	20.4
16160, 16243.....	Subsoil.....	.0	.3	.5	1.9	6.1	58.8	31.9

SUMMARY.

Talladega County, Ala., is situated above the parallel of 33° north latitude and to the northeast of the geographical center of the State. It comprises an area of 479,808 acres, or 749.7 square miles.

Its surface features are diversified, ranging from undulating valleys to hills, ridges, and even mountains. The elevations above sea level range from 400 feet where the Coosa River leaves the county to 1,919 feet on the highest point of the mountainous ridges on the eastern boundary of the county.

The drainage of the county is effected by Choccolocco, Talladega, Tallasseehatchee, and Cedar creeks and their tributaries. These streams flow into the Coosa River, which forms the western boundary of the county.

The settlement of the county was begun between 1828 and 1830. The settlers were of English descent and came from Georgia, the Carolinas, and Tennessee. The population now represents practically all sections of the country, though the descendants of the early settlers are still in the majority. There is also a large negro population. According to the last census the population of the county was 35,773. The city of Talladega, with about 7,000 population, is the county seat. Other principal towns are Sylacauga, Childersburg, Sycamore, Munford, and Lincoln.

The transportation facilities are exceptionally good. Two railroads traverse the county north and south and three east and west, while another now building will afford connection with the larger towns and cities of this and adjoining States and with the Gulf and Atlantic seaports.

The market for all products of the farm is found in the local towns. The principal product sold is cotton. Poultry and eggs are also important items sold to the local markets and for shipment.

The rock formations underlying this area are varied. Intense geologic activity at some past time, by which the section was submerged and elevated, folded and faulted, has rendered the geology complex. Two groups of rocks are represented—old metamorphic rocks, consisting of hydro-mica and imperfectly crystalline slates of the Appalachian Mountain system, and sedimentary rocks of the Coosa Valley, consisting of a great variety of limestones, shales, and sandstones, some of these in small part metamorphosed to slate, quartzite, and marble.

The soils were derived for the most part directly from the underlying rocks, but the surface material has been deposited or modified in some instances by water in past geologic time. Exclusive of Rough stony land, which covers all areas in soil types too steep and stony to cultivate, 15 types of soil were recognized and mapped. The soils

derived from the purer limestones are much stronger, durable, and productive than those resulting from the more siliceous and cherty limestones, the shales and sandstone, or the metamorphic slates.

The value of the lands varies from \$1 an acre for the rougher, stony, and less productive areas to about \$40 an acre for the heavy red clay land of the valleys. The average value of arable farm lands for the county is from \$10 to \$15 an acre.

The one-crop system is followed, cotton being the main and money crop. It is grown on all soils, with an average yield for the county of one-third bale per acre. In 1899 the yield of cotton was 21,563 bales. The next important crop is corn, with a production of 530,100 bushels in 1899. Some oats, rye, wheat, and potatoes are produced. The acreage of crops for hay and pasture is small. No systematic crop rotation is followed, but dependence is placed upon commercial fertilizers to keep up the productiveness of the soils. Cultural methods are receiving more attention, however, and some improvement is taking place. The farm labor is mainly negro. The tenant system is universal.

There is need of a diversification of crops and of a systematic crop rotation planned to bring about a general improvement of the soils. To this end more cereals and grasses should be grown and more live stock kept. Dairying and stock raising would no doubt prove profitable as well as beneficial. A systematic forestry should be introduced, a large area of the land being adapted chiefly for this use. On the whole, the agricultural conditions of the county are good and the prospects for general betterment are encouraging. As the mineral resources of the region develop and population increases, a greater demand must arise for farm products of all kinds and the farmers will profit thereby.

SOIL SURVEY OF BUTLER COUNTY, ALABAMA.

By A. E. KOCHER and H. L. WESTOVER.

DESCRIPTION OF THE AREA.

Butler County is situated in the south-central part of Alabama, midway between the eastern and western boundaries of the State. It is bounded on the north by Lowndes and Wilcox counties, on the east by Crenshaw County, on the south by Covington and Conecuh counties, and on the west by Conecuh, Monroe, and Wilcox counties. It lies between $31^{\circ} 31' 35''$ and $31^{\circ} 57' 41''$ north latitude and $86^{\circ} 27' 36''$ and $86^{\circ} 55' 13''$ west longitude and has an area of 493,248 acres, or about 771 square miles.

The surface features of Butler County are quite varied. Generally speaking, the topography is hilly or rolling, though limited areas of level land are frequently found on the high plateaus and in the lowlands along the streams. Formerly the topographic features of the county were considerably more uniform than they are to-day. Except in the northwest and southeast corners, where increases of elevations are quite marked, the hilly appearance of the county is not so much due to the presence of old estab-

lished hills as to the occurrence of many deep gullies, which the streams have eroded through the otherwise level plain. While these gullies are not confined to any particular section, they are deepest and most numerous in the northern half of the county, where are to be found the sources of nearly all the streams, which fact accounts for the markedly irregular and broken topography.

By reference to the accompanying soil map it will be seen that the surface of Butler County is exceptionally well drained. Beginning

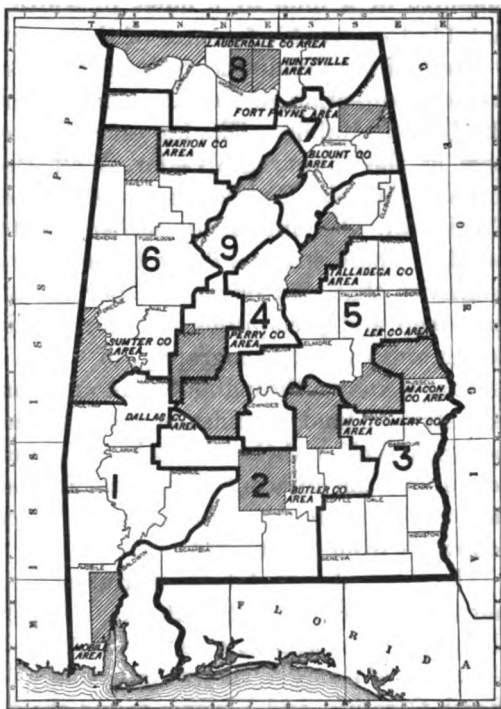


FIG. 14.—Sketch map showing location of the Butler County area, Alabama.

near the point where the Louisville and Nashville Railroad enters the county from the north there extends across the county in a south-westerly direction a low, narrow table-land marked on the map by the position of the old Federal road. This ridge cuts the county into two unequal parts and forms the divide between the two chief systems of drainage. To the east and south of this ridge occur a number of streams, of which the most important are Pigeon, Persimmon, Three Runs, Halls, Rocky, Panther, and Long creeks. These streams all flow in a southerly direction and finally reach the Gulf at Pensacola through the Escambia River and Pensacola Bay. Along their courses flat overflow lands are usually found, flanked on each side by steep slopes from 30 to 60 feet in height. These lowlands range from one-fifth of a mile to 2 miles in width and form one of the most notable topographic features of the county.

West of the divide the drainage waters flow in a westerly or north-westerly direction to the Alabama River, through which they enter the Gulf at Mobile. The largest and most important streams in this part of the county are Cedar, Wolf, Breastwork, and Pine Barren creeks. Muscle, Saddler, and Ishams creeks, tributaries of Cedar Creek, are also important streams entering the county from the north. These streams differ from those in the southern part of the county in that they occupy deeper and narrower valleys, whose walls are steep and precipitous. This condition has given rise to a very rough and rugged topography, of which the most prominent feature is what is known throughout the county as the "ridge." This "ridge" is a strip of land 10 miles or more in length which forms the divide between Wolf and Cedar creeks. Its height ranges from 100 to 200 feet above the adjacent bottoms. In places it has become extremely narrow, being barely wide enough to accommodate the road which follows it from end to end.

The present population of Butler County is made up chiefly of natives of the State of Alabama. According to the census of 1900, the population in that year was 25,760. The first settlers came from the State of Georgia, though later many families from South Carolina, North Carolina, and Virginia found their way to this region.

Although the county was first permanently settled more than ninety years ago, much of it still remains in its original forested condition. According to the census of 1900, only 27 per cent of the total area of the county was classed as improved farms. During the last seven years immigration has added somewhat to the population of the county, especially in the southern part. Fifty years ago one of the principal settlements was on the "ridge" in the vicinity of Cedar Creek, but with the opening of transportation facilities farther to the east this region was almost abandoned by the whites and is now largely occupied by negro tenants.

Greenville, the county seat, with a population of about 5,000, and located on the Louisville and Nashville Railroad, is the largest and most important shipping point. Georgiana, Chapman, Dunham, Garland, and Bolling are small towns on the main line of the Louisville and Nashville Railroad and serve as important shipping points for all farm products. At Chapman and Dunham lumber mills are operated continuously throughout the year, and furnish employment to a large force of men. Three spur railroads, used exclusively for lumbering purposes, lead out from these mills into various parts of the county, making it possible to conduct the industry on an extensive scale. McKenzie, located in the southern part of the county on the Alabama and Florida Railroad, is a growing town and an important shipping point for that part of the area. Scattered throughout the western part of the county are centers of from 200 to 300 inhabitants, of which Forest Home, Monterey, and Man-ningham are the most important.

Except in the southeastern and northwestern parts of the area the transportation facilities are good. The main line of the Louisville and Nashville Railroad crosses the county in a northeast and southwest direction and forms direct connection with Mobile and New Orleans and all the principal cities of the North and East. From Georgiana the Alabama and Florida Railroad, a branch of the Louisville and Nashville, extends 100 miles in a southeasterly direction to Graceville, Fla.

The principal markets for the cotton of the county are Mobile and New Orleans, and for the vegetables and truck Chicago, Cincinnati, and Pittsburg.

CLIMATE.

The geographic position of southern Alabama in the Gulf Coastal Plain is such as to give it a mild, temperate climate. Though the summers are long, the heat is somewhat tempered by the cool breezes from the Gulf, while the winters are short and long periods of cold are exceptional.

As there is no Weather Bureau station in Butler County the data given in the tables below have been taken from the records of the stations at Fort Deposit and Evergreen—the former being located just a few miles outside of the county to the north and the latter 10 miles to the southwest of the county. These figures, which represent approximately the climatic conditions of Butler County, show that the mean temperature during June, July, and August is 80° F., and for December, January, and February about 49° F.

From 1897 to 1904 the average date of the last killing frost in spring at Fort Deposit was March 17 and at Evergreen March 11, while the average date of the first killing frost in fall at Fort Deposit

was November 21 and at Evergreen November 8. Thus it is seen that the growing season for even the tenderest vegetables covers a large part of the year. During the winter months a large variety of forage crops continue to thrive and furnish feed for stock. Most of the plowing is done in January and February, and farming operations can be carried on during every month of the year.

The mean annual precipitation as recorded at the Evergreen station is 52.40 inches, with a good distribution throughout the year. The following tables show the mean annual and monthly temperature and precipitation and the dates of last and first killing frosts at the two stations named:

Normal monthly and annual temperature and precipitation.

Month.	Fort Deposit.		Evergreen.		Month.	Fort Deposit.		Evergreen.	
	Tem- pera- ture.	Precipi- tation.	Tem- pera- ture.	Precipi- tation.		Tem- pera- ture.	Precipi- tation.	Tem- pera- ture.	Precipi- tation.
	° F.	In.	° F.	In.		° F.	In.	° F.	In.
January.....	40.2	4.58	48.2	3.00	August.....	80.0	.....	80.0	5.26
February....	49.4	5.86	81.1	6.14	September...	75.9	2.36	74.9	3.13
March.....	57.6	6.30	87.2	5.64	October.....	65.3	2.74	64.8	2.23
April.....	66.2	3.64	85.5	3.69	November..	55.7	3.78	56.0	2.18
May.....	73.9	3.02	72.7	2.58	December...	49.5	4.84	49.8	5.86
June.....	79.4	4.42	78.3	6.35					
July.....	81.2	4.71	80.6	6.34	Year....	65.0	.....	64.9	52.40

Dates of first and last killing frosts.

Year.	Fort Deposit.		Evergreen.		Year.	Fort Deposit.		Evergreen.	
	Last in spring.	First in fall.	Last in spring.	First in fall.		Last in spring.	First in fall.	Last in spring.	First in fall.
1897.....	Mar. 3	.....	Mar. 1	Nov. 30	1902.....	Mar. 20	Nov. 28	Mar. 18	Nov. 27
1898.....	Apr. 6	Nov. 22	.....	Oct. 27	1903.....	Feb. 25	Oct. 25	Feb. 22	Oct. 24
1899.....	Apr. 6	Dec. 5	.....	Nov. 5	1904.....	Mar. 4	Nov. 28	Mar. 4	Oct. 24
1900.....	Mar. 18	.....	Apr. 5	Nov. 10	Average.	Mar. 17	Nov. 21	Mar. 11	Nov. 8

AGRICULTURE.

The first permanent settlement made in Butler County was in 1815, near what is now known as Pineflat. In 1819 the county was regularly organized, and two years later Greenville was founded as its county seat. About this time agriculture began to be developed in the northwestern part of the county on the rich bottom lands of Wolf and Cedar creeks. At first the planters built their homes on the lowlands which they farmed, but finding the location unhealthy they soon moved their families to the high, sandy "ridge," where for over half a century they continued to live and till the rich alluvial lowlands. From the first, cotton and corn were the chief crops grown. Sufficient wheat and vegetables for home consumption were also pro-

duced. Cattle and hogs were soon introduced and all the meat used was produced at home. No fertilizer was used and the meager cultivation which the land received soon caused the lighter types of soil to become worn and unproductive. As this occurred the corn and cotton crops were moved to newer fields, while the old lands were abandoned and allowed to grow up to forests of scrub pine. Until about 1860 the farmers continued to grow their own wheat, the thrashing being done by thrashers usually stationed at the cotton gins. But with the high price of cotton immediately following the civil war the wheat crop was dropped from the rotation and a larger acreage was devoted to the production of the former crop.

The completion of the railroad from Montgomery to Mobile opened a market on the Gulf and gave a great stimulus to the agriculture of the county, especially to the production of cotton. When the price of this staple began to decline the acreage of oats was increased, reaching 15,350 acres in 1885, though in 1900, according to the Twelfth Census, it had dropped again to only 4,618 acres. In 1885, however, the acreage of cotton was twice that of corn. During the last few years the production of oats has again increased, it having been found more profitable to raise this grain for stock than to devote so large an acreage to the production of corn.

The introduction of truck crops in the vicinity of markets has also had a salutary effect on the agriculture of the county in encouraging the diversification of crops.

According to the census of 1900, the total value of products not fed to live stock was \$1,325,370. Of this amount \$1,057,350 represented cotton alone. The miscellaneous vegetables were valued at \$32,991, and the 1,181 acres of sugar cane grown produced 125,421 gallons of sirup, which was valued at about \$50,000. Although the trucking industry has been introduced recently, the crops grown have been of splendid quality and have brought good prices in the northern markets.

As a rule, little attention is given to the adaptability of the different soils to crops. Cotton and corn are grown on all the soils, regardless of the open structure of some of the sandy types. Where facilities for marketing can be had the adaptability of the Norfolk fine sand and the Orangeburg soils to fruit and truck crops is generally recognized. However, the chief rotation practiced in the county is cotton followed by corn, and cotton again the third year. In late years it has become the custom to plant cowpeas in the cornfields during the latter part of the summer, in which case the crop not only furnishes good fall pasturage, but also leaves in the soil a large quantity of nitrogen and organic matter.

The methods used in Butler County are those peculiar to the Southern cotton States. Only on the heavy soils are 2-horse implements

used, and even then the plowing is shallow. The lighter soils are usually broken with a small 1-horse plow in January or February to an average depth of from 3 to 5 inches. In preparing the land for cotton or corn the most usual practice is to turn two furrows together in such a way as to form a ridge between the rows of the previous season. Later two other furrows are thrown to this ridge and the preparation for the crop is complete. Sometimes the land is plowed only where the crop is to be planted, the ground between the rows being left untouched until the summer cultivation. This practice is very unprofitable, as the crops produced are usually small. Where the land is subject to erosion, terraces are constructed, and considerable attention is given to making the rows conform to topography. Very little machinery is used in the county. Oats are usually sown by hand in the fall. During the last few years it has been a common practice to sow them on unplowed ground and cover them with a common turning plow. No grain is thrashed, the oats being cut for hay or bound and fed to stock in the sheaf.

Except in a few localities the fertilizing value of cotton seed does not seem to be appreciated. A large proportion of the cotton seed produced in the county is sold at the oil mills, though the price received is less than their value if used as a fertilizer at home.

According to the United States census of 1900, \$54,500 was expended for commercial fertilizers alone, while the total expense for labor for that year was only \$64,080. The usual wage paid ranges from \$10 to \$15 a month. In the spring, when extra help is needed for chopping cotton, laborers are paid from 50 to 75 cents a day, with partial board, and in the fall, when cotton is picked, from 50 to 75 cents per 100 pounds—the women and children being important factors in the gathering of the crop. The labor of the farms is almost exclusively of the negro race. The authority quoted gives the proportion of the farms of Butler County operated by the owners as 40 per cent, and this is probably about the proportion to-day. Most of the rented land is worked for a part of the crop, the owner receiving one-half of the crop when he furnishes the land, teams, buildings, and implements, and one-third of the corn and one-fourth of the cotton when he furnishes only the land. When cash rent is paid, about \$2.50 an acre is the average rate.

In 1900, according to the Twelfth Census, the county contained 334,719 acres in farms, of which 134,763 acres, or about 40 per cent, was improved. The average size of the farms was 103 acres. The total value of farm lands in 1900, including buildings and improvements, was \$1,830,925. A large proportion of the farm lands of the county is held at from \$4 to \$7 an acre, although a few of the farms near Greenville and in the vicinity of Forest Home are valued as high as \$100 an acre.

The great needs of the agriculture of the county are a greater variety of crops and more thorough cultivation. Instead of using the land almost entirely for cotton and corn, other crops, such as fruit, tobacco, Irish potatoes, and a variety of truck should be introduced. Rarely should a rotation be practiced which does not provide for live stock on the farm, which means that grasses, peas, velvet beans, and other forage crops must be grown as well as cotton and corn. Such a practice would not only furnish at nominal cost a large amount of valuable fertilizer, but a cover crop for the soil throughout the winter months, which would be of much service in preventing the damage of fields by erosion.

Although the practice of terracing the land is quite general, many valuable areas throughout the county are ruined each year by erosion. To aid in preventing this waste the land should be plowed deeper and the heavy subsoil brought up and mixed with the soil. In some cases where erosion has just begun it would doubtless be well to discontinue cultivation, first seeding to grass and turning the land into a range for stock. For this purpose no better crops can be found than Bermuda grass and burr clover. The dense roots of the Bermuda grass soon take possession of the soil, binding it firmly in place, while the combination of plants makes excellent pasturage for stock the year round.

Throughout the county a more thorough system of cultivation is badly needed, but during the last few years the supply of available labor has been gradually growing less, while the acreage of cotton has remained about the same, if it has not actually increased. Under these conditions the acreage of cotton should be reduced and a greater proportion of the land devoted to live stock. The advantages of such a course are obvious. The introduction of live stock would provide another much-needed source of revenue and would have a tendency to build up worn-out land. By reducing the cotton acreage a saving would be effected in the outlay for commercial fertilizers, while the better culture which could be given the crop would result in the production of a greater quantity of lint per acre at a reduced cost per pound.

SOILS.

Butler County lies near the northern limits of the physiographic division of the United States known as the Gulf Coastal Plain. The soils are derived from the weathering and reworking of marine deposits. Broadly speaking, they may be divided into two general classes—the upland or sedimentary soils, and the lowland or alluvial soils.

Owing to the different sources from which the materials have been derived and because of present differences in color, structure, and

drainage, the soils of the uplands fall naturally into the four groups or series. These are called the Orangeburg, Susquehanna, Norfolk, and Houston series, the soils belonging to the first three series occupying probably four-fifths of the entire area of the county. As the material forming distinct series differs in texture or in depth, it is again divided into separate classes known as soil types. Thus the Orangeburg series is represented in the county by five soil types, the Norfolk series by three, and the Susquehanna series by two, while the Houston possesses only one.

Geologically, the formation of the soils dates from three great periods or ages—namely, the Cretaceous, the Tertiary, and the present. Although Cretaceous rocks occur more or less generally throughout the northern part of the county, the formation gives rise to but one soil type. This type, designated on the accompanying map as Houston clay, is a heavy black soil found only in limited areas in the northwest corner of the county.

The Eocene-Tertiary has contributed more to the soils of the county than has any other geological horizon, being represented by the Clayton, Lignitic, and Claiborne stages. These formations, while sufficiently distinct in a geological sense, do not differ enough in essential features to impress marked characteristics on the soils derived from them. Hence the types occurring on the one are as frequently found occurring on the other.

The chief evidences of the Clayton stage are found in the limonite rocks, which occur throughout the Orangeburg and Susquehanna soils to the north of Greenville, in the vicinity of Searcy Station. Immediately south of this formation begin the soils of the Lignitic stage, which cover the greater part of the area. Only in the rough, hilly section in the southeast corner of the county is the influence of the Claiborne stage in evidence. Here the soils are still of the Orangeburg and Susquehanna series and do not differ materially from those in other parts of the county.

Except in the lowlands of Wolf and Cedar creeks, where a heavy, black phase of Meadow occurs, most of the alluvial soils are found in the southern half of the county. These, exclusive of Meadow, consist of three types—Myatt fine sand, Myatt fine sandy loam, and Ocklocknee clay. With the exception of the latter type, and the black clay in the northwest corner of the county, all the alluvial soils are covered by a mantle of fine gray sand. The black clay above referred to is derived from the adjoining type of Houston clay, and if found in sufficient extent would doubtless be correlated with the Wabash clay of other areas.

The county has 16 distinct soil types, all of which are common to the other States of the Gulf Coastal Plain. Usually the corresponding types of the same series are in the main identical, though minor,

unimportant variations are sometimes noted. Examples of such variations in Butler County are seen in the Norfolk and Susquehanna fine sandy loams. Here the yellow clay subsoil of the Norfolk fine sandy loam is of a reddish hue, while in the States west of the Mississippi River it is more frequently a bright yellow. So, too, the subsoils of the Susquehanna fine sandy loam sometimes differ slightly, due to the fact that in Butler County the underlying Cretaceous rock is considerably nearer the surface than it is in some other areas.

The following table gives the names and areas of the several soil types shown on the accompanying map:

Areas of different soils.

Soil.	Acres.	Percent.	Soil.	Acres.	Percent.
Susquehanna fine sandy loam.....	147,072	29.8	Norfolk sand.....	20,544	4.2
Orangeburg fine sandy loam.....	89,856	18.2	Houston clay.....	10,880	2.2
Myatt fine sandy loam.....	41,536	8.4	Greenville fine sandy loam....	9,152	1.9
Meadow.....	37,248	7.5	Orangeburg sand.....	4,096	.8
Orangeburg fine sand.....	34,304	6.9	Orangeburg sandy loam.....	3,264	.7
Norfolk fine sandy loam.....	25,472	5.2	Orangeburg clay.....	1,728	.4
Norfolk fine sand.....	23,296	4.7	Ocklocknee clay.....	768	.2
Susquehanna clay.....	22,656	4.6	Total.....	493,248	.....
Myatt fine sand.....	21,376	4.3			

ORANGEBURG FINE SAND.

The soil of the Orangeburg fine sand consists of from 15 to 36 inches of gray fine sand. At an average depth of 20 inches begins a red, sandy clay which continues to a depth of several feet. The surface when the fields are dry is almost white and resembles the soil of Norfolk fine sand, the only difference between the two types being in the depth and character of the subsoil. The soil is free from stones or gravel and the loose structure makes it easy to cultivate.

The Orangeburg fine sand is of relatively small extent, though it occurs in a number of small bodies scattered throughout the county, being most prominent in the vicinity of Greenville and along the west side of Pigeon Creek. It usually occupies level uplands or gentle slopes leading down to streams. Both surface drainage and under-drainage are good. The soil retains moisture fairly well.

The Orangeburg fine sand is a sedimentary soil formed by the weathering of the Lafayette clays and sands. The native vegetation is red oak, black-jack oak, post oak, and hickory.

The type responds quickly to fertilization and admits of cultivation under a wide range of moisture conditions. Besides the staple crops the soil is adapted to peaches, tomatoes, melons, and other early truck. At present, aside from a few small peach orchards, the land is used only in the production of cotton and corn. The yield of cotton

is one-fourth to one-half bale per acre, with an average of about one-third bale; corn yields from 12 to 20 bushels, with an average of about 15 bushels per acre.

As is the case with all the sandy soils of the area, the greatest need of the type is more organic matter. In the absence of live stock this can be best supplied by turning under green manures. For this purpose cowpeas will prove a valuable crop, adding not only organic matter but considerable nitrogen to the soil.

Except in the southern part of the county, a large proportion of the Orangeburg fine sand is under cultivation. The value ranges from \$7 to \$15 an acre, depending on location and improvements.

The following table gives the results of mechanical analyses of this soil type:

Mechanical analyses of Orangeburg fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16367.....	Soil.....	0.7	4.0	5.5	45.4	25.9	14.2	4.4
16368.....	Subsoil.....	.6	5.0	3.3	29.8	23.0	14.6	23.0

ORANGEBURG SANDY LOAM.

The Orangeburg sandy loam to a depth varying from 4 to 15 inches consists of a medium gray to brown sand or light sandy loam. At an average depth of about 10 inches the soil gives place to a red sandy clay containing a high percentage of mica, iron concretions, and small gravel. There are compact layers through both soil and subsoil, probably due to the presence of lime and iron salts. Except for this the soil is mellow and easily tilled.

As is the case with all the coarser soils, the Orangeburg sandy loam occurs only in the northern part of the county. The principal bodies are found on what is known as the "ridge" in the vicinity of Manningham and Forest Home. The topography is hilly and broken, the type being found on high ridges and steep slopes, which positions insure excellent surface drainage.

The Orangeburg sandy loam is a sedimentary soil derived from the Lafayette formation. In its original condition the material consisted of clay covered by a mantle of soil much deeper and heavier than at the present time, but the rain waters have carried away most of the fine material in the soil and left only a shallow covering of coarse sand above the clay.

Where unimproved the soil supports a growth of red oak, white oak, post oak, and hickory. If well fertilized it is productive and adapted to a variety of crops. Peaches, small fruits, and early truck should do well and could doubtless be produced at a good profit on the areas nearest to markets and shipping points.

The principal crops grown at present are cotton and corn. The former yields from one-fourth to one-half bale per acre, with an average of about one-third bale, and the latter from 12 to 20 bushels, with an average of about 16 bushels per acre.

Owing to the open structure of the soil and the shallow plowing practiced the land dries out rapidly in the spring and may suffer from drought during the growing season. The soil is deficient in organic matter and would be greatly benefited by deeper plowing and the turning under of leguminous crops as green manures.

About one-half of the Orangeburg sandy loam in the county is under cultivation. It is held at from \$7 to \$10 an acre.

The results of mechanical analyses of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Orangeburg sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16359.....	Soil.....	0.0	5.4	22.7	37.9	14.4	16.8	2.9
16360.....	Subsoil.....	4.8	15.4	5.7	18.1	10.0	16.7	29.6

ORANGEBURG FINE SANDY LOAM.

The soil of the Orangeburg fine sandy loam is a gray medium to fine sand or fine sandy loam. The depth ranges from 4 to 15 inches, with an average of about 10 inches, where a subsoil of a red sandy clay is found extending to a depth of 36 inches or more. Scattered over the surface frequently occur small iron concretions and iron sandstones, but these are never so numerous as to interfere with cultivation.

The Orangeburg fine sandy loam is widely distributed in Butler County. The most extensive bodies are found east of Greenville and in the western part of the county in the vicinity of Forest Home, Monterey, and Pineflat. Smaller bodies occur in various parts of the county. The Orangeburg fine sandy loam has a variety of topographic features, ranging from steep, rugged hillsides to broad, level plains. The larger bodies, especially those near Greenville and at Forest Home, are level or gently rolling. As a rule, the drainage is good; in fact, on the hillsides it is apt to be excessive. East of Greenville there are several square miles of almost level land and there the drainage is rather poor. Tile drains would be of great benefit in that area, especially during the wet spring months.

The Orangeburg fine sandy loam is derived from the sands and clays of the Lafayette formation. The native vegetation is red oak, white oak, hickory, and longleaf yellow pine. Near Pineflat is one of the most productive bodies of this type, made so, it is said, by the

decay of the plant remains derived from the heavy growth of oaks and hickory which originally covered this section. East of Greenville and in the vicinity of Forest Home a greater proportion of the forest growth was pine, which in its decay seems to contribute less to the soil than do the hardwoods.

The Orangeburg fine sandy loam is one of the earliest soils in the county, and is admirably adapted to the production of fruits and truck crops. Peaches especially do well, though as yet only a few orchards of commercial importance are planted on this soil. Judging from the success which has attended the growing of Cuban seed tobacco on the Orangeburg fine sandy loam in other sections of the State, there seems little doubt that the same type of leaf can be successfully grown in Butler County.

The soil is also well adapted to the production of strawberries, though the difficulties of securing labor and, in many cases, the present lack of transportation facilities are drawbacks to the development of the industry. Cotton and corn are the chief crops grown, and as much of the type lies far from markets a large part of it will continue for some time to be used in the production of these crops. However, near the main line of the Louisville and Nashville Railroad, where shipping facilities can be secured, a profitable trucking industry has been built up, the most notable examples of success being in the vicinity of Greenville and Dunham. Here radishes are said to net the grower \$300 an acre, onions yield from 250 to 500 bushels, Irish potatoes from 75 to 150 bushels, and sweet potatoes from 250 to 500 bushels per acre. The yield of cotton on this soil ranges from one-third to three-fourths bale per acre, with an average of about one-half bale. Corn yields from 15 to 30 bushels, with an average of 20 bushels per acre. Little difference is observed in the value of this type and the Greenville fine sandy loam. It is said by some, however, "that for the production of radishes the gray surface soil is somewhat better, while for cotton and corn the red soil of the Greenville fine sandy loam is more desirable."

As is common on most of the soils of the area, ridge cultivation is practiced, and the plowing is usually very shallow. Many fields have been in cultivation from twenty to forty years, and during this time the soil has never been broken more than 4 or 5 inches deep.

Naturally such fields are producing only nominal yields. As the type is easily affected by drought, more attention should be given to the storing of moisture in the soil. To do this the land should be plowed deeper in the spring and given more frequent shallow cultivations throughout the growing season. Incorporating organic matter in the soil will also greatly increase its power to hold moisture. The use of barnyard manure and green manuring crops will accomplish this. For cotton and corn from 200 to 300 pounds of com-

mercial fertilizer is used per acre. This is usually mixed in the proportions to give 8 per cent of phosphoric acid, 2 per cent of ammonia, and 2 per cent of available potash. For early truck crops better results are said to be secured by the use of a better grade of fertilizer containing 8 per cent of phosphoric acid, $3\frac{1}{2}$ per cent of ammonia, and 6 per cent of potash, and from 1,000 to 1,500 pounds of this mixture is applied per acre.

The Orangeburg fine sandy loam is considered one of the most desirable soils in the county, being both early and productive. A larger proportion of the type is under cultivation than of any other soil in the area, and wherever the type is found agriculture is in a prosperous condition.

The value of the land ranges from \$7 an acre for uncleared bodies far from market to \$50 or more an acre for improved areas in the vicinity of Greenville and Forest Home.

The results of mechanical analyses of typical samples of the Orangeburg fine sandy loam are given in the following table:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16361.....	Soil.....	0.4	2.3	1.3	19.1	37.5	31.9	7.3
16362.....	Subsoil.....	.1	1.4	.9	16.9	31.8	23.7	25.6

ORANGEBURG SAND.

The Orangeburg sand consists of from 15 to 20 inches of a gray or red, medium-textured sand, underlain by a subsoil of red sand, beneath which at a depth of 20 to 30 inches occurs a red sandy clay. Large fragments of ferruginous sandstone are sometimes found scattered over the surface, but they rarely are so numerous as to interfere with cultivation.

The Orangeburg sand occurs only in limited areas and in the northern part of the county. The most noticeable bodies are found 1 to 3 miles northwest of Greenville, in the vicinity of Manningham, Monterey, and Ridgeville, and in the northeast corner of the county. The type is found on high plateaus and ridges and the surface is both level and rolling. The drainage is always ample for agricultural purposes and on the rolling areas is frequently excessive.

The Orangeburg sand, like all the soils of the Orangeburg series, is formed by the weathering of the materials of the Lafayette formation. The soil is very similar to the Orangeburg fine sand, the only difference being in the texture of the surface soil. This difference has been brought about mainly by the action of rains, which have washed away the finer particles and left only the coarser ones.

Where the land is uncleared it is occupied by sand jack, black-jack, red, and post oak.

For ordinary crops unless well fertilized the Orangeburg sand is only moderately productive. It is well adapted to peaches, berries, melons, and all early truck. Under skillful management it is probable that a fine grade of filler tobacco could also be produced. Though only fair yields of cotton and corn are secured the most of the type in cultivation is devoted to the production of these crops. On account of its loose structure the soil would be much improved by the addition of organic matter.

Only about one-third of the Orangeburg sand in the county has been cleared and brought under cultivation. Its value ranges from \$7 to \$10 an acre.

The results of mechanical analyses of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Orangeburg sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16357.....	Soil.....	4.3	25.5	16.2	27.3	6.1	14.6	6.2
16358.....	Subsoil.....	1.7	21.2	14.3	21.8	5.4	8.6	26.1

ORANGEBURG CLAY.

The Orangeburg clay consists of 1 to 4 inches of red fine sand or fine sandy loam overlying red sandy clay. Both soil and subsoil contain a high percentage of ferruginous sandstone and iron concretions, but these are not so numerous as to interfere seriously with farming operations.

Owing to its limited extent the Orangeburg clay is of but little importance in Butler County. It is found in the vicinity of Greenville in small bodies ranging in size from 10 to 400 acres. The topography is level or gently rolling and the drainage is usually good. The Orangeburg clay is sedimentary, and, like the other soils of the Orangeburg series, owes its formation to the weathering of the Lafayette. It originally supported a growth of red oak, post oak, and hickory.

Peaches, pears, and small fruits do well on this soil, though only small quantities are grown. It is probable a high grade of filler tobacco could be profitably produced. The yields of cotton range from one-third to three-fourths bale and of corn from 15 to 30 bushels per acre.

On account of the compact structure of the subsoil the plowing is usually very shallow, and in consequence a hard layer has been formed a few inches below the surface. As the heavy clay subsoil has naturally a high capacity for moisture, this shallow plowing is doubtless responsible for the soil drying out so rapidly during the

growing season. Deeper plowing and the incorporation of organic matter in the soil would be very beneficial in this respect.

Nearly all the Orangeburg clay is under cultivation. Its value ranges from \$7 to \$25 an acre.

The results of mechanical analyses of the soil and subsoil of this type are shown in the following table:

Mechanical analyses of Orangeburg clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16355.....	Soil.....	0.0	1.2	4.6	39.5	9.6	18.7	26.3
16356.....	Subsoil.....	.4	3.0	4.4	26.0	8.3	14.9	42.8

GREENVILLE FINE SANDY LOAM.

The soil of the Greenville fine sandy loam is a red sandy loam of fine to medium texture, ranging in depth from 4 to 15 inches. The subsoil to a depth of several feet is a bright-red sandy clay. Over much of the type the red clay is found within 6 or 8 inches of the surface, and where such areas occur the soil is a heavy, fine sandy loam containing a relatively large amount of silt and clay.

The type differs from the Orangeburg fine sandy loam chiefly in the color of its soil, it being a uniformly bright-red color instead of the gray of the Orangeburg fine sandy loam.

The Greenville fine sandy loam, though an important soil type, is one of the least extensive in the county, its total acreage being less than 2 per cent of the area mapped. The type occurs immediately east of Greenville, between Pigeon and Little Pigeon creeks and in the vicinity of Glasgow post-office. It occupies level plateaus, and as they always lie in close proximity to streams the drainage is usually good. A few of the more level areas, however, in the vicinity of Greenville would be greatly improved by tile drains.

In origin the soil is residual, being formed by weathering of the Lafayette clays. The original growth was chiefly red oak, white oak, post oak, and hickory, very little pine being found on this type.

The Greenville fine sandy loam if well drained is the earliest soil in the county, and is well adapted to fruits and early truck crops. Under equal conditions it is considered a somewhat more productive soil for cotton and corn than is the gray-surfaced Orangeburg fine sandy loam. It should also produce a high-grade Cuban leaf tobacco, and there is an opportunity to develop a paying industry in the production of this crop. Irish potatoes, radishes, onions, etc., are grown on this soil and give large returns. Cotton and corn, however, are the chief crops, the yields ranging from one-third to three-fourths bale and from 15 to 30 bushels per acre, respectively. Inasmuch as good shipping facilities at Greenville are close at hand, it

would undoubtedly be found much more profitable to reduce the acreage of cotton and corn and to grow such additional crops as peaches, berries, and small fruits, as well as Irish potatoes, radishes, onions, etc. On account of its position and wide range of adaptation this soil is considered the most desirable in the county, some of the areas being held as high as \$100 an acre.

NORFOLK SAND.

The soil of the Norfolk sand, to a depth of 6 inches, consists of loose, incoherent gray sand, usually containing but a small quantity of organic matter. The subsoil, which is uniform to a depth of several feet, is an orange sand of about the same texture as the soil. The texture of the Norfolk sand in Butler County varies considerably, being sometimes composed chiefly of coarse and medium sand and again of medium and fine sand with small quantities of coarse material. Quartz pebbles, varying in size from one-eighth to three-eighths of an inch in diameter are usually abundant in both soil and subsoil. In newly cleared areas the surface has a loamy appearance, owing to the presence of a relatively high content of organic matter, but under the present system of cultivation the organic matter soon disappears.

The areas of Norfolk sand in this county vary from 10 acres to several square miles in extent. The principal areas are found in the northwestern part of the county along Wolf, Pine Barren, and Breastwork creeks, in the vicinity of Forest Home, Butler Springs, and Monterey. There are also a few areas in the northeastern part along Three Runs and Pigeon creeks. The type generally occurs as gently sloping areas in the valleys of these streams, although some areas are comparatively level. The sloping areas are subject to erosion, and gullies several feet in depth are frequently found.

Owing to its loose, incoherent structure and sloping topography, the type is naturally well drained. With thorough cultivation, however, it withstands droughts much better than some of the more compact soils.

The Norfolk sand is a sedimentary soil and probably owes its origin to beach deposits of the Tertiary and Quaternary ages. It occurs as a sandy mantle overlying the Lafayette clays. The native vegetation was post oak, black-jack oak, sand-jack oak, and hickory.

Inasmuch as the soil does not retain moisture well it is not adapted to general farm crops, but peaches, melons, small fruit, and early truck should do well. Excepting a little fruit and vegetables for home use, cotton and corn are practically the only crops grown at present. The yields of cotton range from one-fifth to one-third bale, and of corn from 10 to 15 bushels per acre.

As is general throughout the county, in preparing the land for cotton the soil is thrown up in ridges and the seed planted later on top

of these. Such a method allows the escape of a greater proportion of moisture from a soil which is already apt to be deficient in water content, and the low yields are in part due to this practice. The lack of moisture could be remedied to a certain extent by level cultivation and by incorporating organic matter in the form of cowpeas or some other leguminous crop, and if this soil is to be used in the cultivation of the staple crops changes in methods can not be urged too strongly.

About 75 per cent of the Norfolk sand is under cultivation. Mainly because of the distance from markets most of the land can be bought at from \$3 to \$8 an acre.

The results of mechanical analyses of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Norfolk sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16349.....	Soil.....	4.4	38.0	18.4	17.3	6.6	12.4	2.6
16350.....	Subsoil.....	3.1	32.2	16.0	18.1	8.6	19.2	2.7

NORFOLK FINE SAND.

The soil of the Norfolk fine sand consists of loose, incoherent fine sand 10 inches or more in depth. On the surface the color is dark gray or light brown, the shades becoming lighter with increasing depth. The subsoil is a pale-yellow sand of about the same texture as the soil.

No large bodies of Norfolk fine sand are found in Butler County. The type, however, is a very general one, occurring in all sections of the county in bodies varying from a few acres to 1 or 2 square miles in extent. The largest and most numerous areas are found in the southern part, in townships 7 north and ranges 13 and 14 east.

The type occupies high, level plateaus or gently sloping areas along the larger streams. On account of these positions and the loose, open structure of the subsoil the type is well drained.

The Norfolk fine sand is a sedimentary soil laid down in a sea during the latter part of the Eocene period. On some of the slopes the type has been formed by the deposition of material washed down from the higher lying soils.

The native forest growth consists of longleaf pine and various kinds of oaks, of which the black-jack, sand-jack, red, and post oak are the leading varieties.

The Norfolk fine sand is a typical trucking soil, being especially adapted to the production of light truck crops. It is early, easily handled, responds well to fertilization, and can usually be worked within a few hours after heavy rains. In the vicinity of Greenville

radishes are very successfully produced, netting the grower from \$200 to \$300 an acre. Strawberries are also grown to some extent, and are a profitable crop where facilities can be had for handling and marketing them.

Notwithstanding the adaptability of the Norfolk fine sand to the production of early truck crops, more than 90 per cent of the cultivated areas is devoted to cotton and corn. The yields of cotton range from one-fifth to one-half bale per acre, depending on the character of culture. Corn yields from 10 to 15 bushels per acre, with an average of about 12 bushels.

The plowing is usually done with a 1-horse plow and as a result is very shallow. The soil is badly in need of humus, especially where the land has been cropped for several seasons. To supply this, leguminous crops—such as cowpeas or velvet beans—should be grown and turned under as green manure.

The fertilizers most commonly used on the Norfolk fine sand are cotton seed, acid phosphate, and kainit, from 200 to 300 pounds being applied to the acre for cotton and a somewhat less quantity for corn. When radishes are grown a much larger application—from 1,500 to 2,000 pounds to the acre—has been found profitable.

About 75 per cent of the Norfolk fine sand in Butler County is under cultivation. The value ranges from \$3.50 to \$20 an acre, depending on location and improvements.

The results of mechanical analyses of the soil and subsoil of this type are shown in the following table:

Mechanical analyses of Norfolk fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16351.....	Soil.....	0.3	2.3	5.8	36.1	33.0	17.4	4.2
16352.....	Subsoil.....	.1	1.9	5.3	35.9	33.6	16.0	6.9

NORFOLK FINE SANDY LOAM.

The soil of the Norfolk fine sandy loam consists of about 3 inches of dark-gray to light-brown loamy fine sand, resting on a stratum of gray fine sand from 15 to 20 inches deep. Below this depth the subsoil is a yellow sandy clay, which on the higher elevations extends to a depth of several feet. In the low-lying areas where drainage is poor the virgin soil is somewhat more loamy and the subsoil is frequently marked with gray.

The Norfolk fine sandy loam is found in all parts of the county, except in the northwestern corner, forming a large number of small bodies ranging from 10 acres to 1 or 2 square miles in extent. The largest and most numerous areas occur in the south-central part, in the vicinity of Bolling and Georgiana.

Excepting a few slightly rolling areas on the uplands, the topography of the Norfolk fine sandy loam is rather level. The type frequently occurs in narrow strips along the lower slopes of hills and along stream channels. In such cases it usually adjoins one of the low-lying types of the Myatt series, to which it seems to be closely related in structure, texture, and general appearance. The drainage of the upland areas is good, but the lower lying bodies receive much seepage water from higher lying areas and the drainage is frequently poor.

The Norfolk fine sandy loam is derived through the weathering of marine beds deposited in the Lignitic stage of the Eocene period.

The timber growth is red oak, white oak, hickory, and longleaf yellow pine on the upland areas, and white oak, gum, and loblolly pine on the lowland bodies of the type. Grasses would doubtless do well on these lower lying areas, and they should furnish an excellent range for cattle. The better drained areas are well adapted to the growing of late truck crops, and in certain sections of the South this soil is highly esteemed for the production of bright yellow tobacco.

The chief crops grown are cotton and corn. The former yields from one-fourth to two-thirds of a bale, with an average of about one-third bale, and the latter from 15 to 25 bushels, with an average of about 18 bushels, per acre. In the vicinity of Bolling strawberries are grown on this type to a limited extent and are proving to be a profitable crop.

Owing to its wet condition in the spring the land is usually broken in high ridges for the purpose of eliminating soil moisture as much as possible. A better way to control this water would be by open ditches or tile drains. This would permit not only of level breaking in the spring, but also of subsequent shallow cultivation, thus conserving more of the moisture in the soil during the growing season, when it is most needed. The fertilizer practice on this type is usually the same as that on the other soils of the area, namely, the application of 200 to 300 pounds of mixed commercial fertilizers per acre.

Only a small part of the type is under cultivation. The price ranges from \$4 to \$25 an acre.

Below are given the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16353.....	Soil.....	0.5	3.9	5.0	38.3	21.1	24.3	6.1
16354.....	Subsoil.....	.7	2.6	3.6	28.5	11.5	25.6	27.6

MYATT FINE SAND.

The Myatt fine sand consists of 6 to 10 inches of gray or drab fine sand occasionally mottled with brown or orange, underlain by a mottled gray and yellow silty fine sand extending to a depth of 20 inches. Below this the subsoil varies from a mottled gray and yellow silty fine sand to a silty clay of the same color. In low, wet areas, where large amounts of organic matter have accumulated, the surface soil has a decidedly black appearance. Nearly all of the Myatt fine sand is found in the southern half of the county along Pigeon, Persimmon, Panther, and Rocky creeks and their branches. The largest areas are found in the vicinity of Bolling and from 1 to 2 miles east of Georgiana.

The type occupies a somewhat more elevated position than the Myatt fine sandy loam, occurring as narrow ridges, many of which are too small to be mapped, along the banks of all the streams in the southern part of the county. These ridges are flanked by low-lying areas of Myatt fine sandy loam, which are in turn separated from the upland soils by other bodies of Myatt fine sand.

Because of its low-lying position the land is heavily taxed to dispose of all the drainage waters which collect upon it from the uplands. For this reason artificial drainage is not only beneficial, but in most cases is a necessity if the land is to be cultivated. During the greater portion of the year tile drains or blind ditches would prove sufficient, but in times of heavy rainfall open ditches are a necessity. To avoid the inconvenience in cultivation and the waste of space arising from so many open ditches, the most satisfactory method would probably be to have the main ditches open and the laterals tile or blind ditches. When thoroughly drained in this manner the soil would become loose and porous and therefore easily tilled.

The Myatt fine sand is alluvial in origin, having been formed by the deposition of sand particles carried in suspension by the streams. This sediment is derived chiefly from the surface soils of the Orangeburg and Susquehanna series in the upper courses of the streams.

Not more than 20 per cent of the Myatt fine sand is naturally well drained, of which only a small proportion is under cultivation. The greater part is still covered by a forest of loblolly and yellow pine, gum, magnolia, beech, and a dense growth of gallberry bushes.

On account of the wet condition of the land in spring it is usually thrown up in ridges to facilitate drying out before the preparation for planting begins. The soil responds readily to commercial fertilizer, the usual application being from 200 to 300 pounds to the acre. Since the cultivated areas are usually deficient in organic matter the soil would be greatly improved by the plowing under of leguminous crops as green manure. While not an early soil in its present condition, it could be greatly improved in this respect by thorough drainage.

When this is done truck and fruit should do well. At present nearly all the cultivated areas are planted to cotton and corn. The former yields from one-third to one-half bale and the latter from 10 to 20 bushels per acre.

The value of the land ranges from \$5 to \$7 an acre, depending on timber growth and market facilities.

The results of mechanical analyses of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Myatt fine sand

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16841.....	Soil.....	.02	0.7	1.8	27.7	47.1	16.5	5.8
16842.....	Subsoil.....	.2	1.0	2.3	30.5	46.9	11.6	7.2

MYATT FINE SANDY LOAM.

The soil of the Myatt fine sandy loam is a gray silty fine sand or fine sandy loam with an average depth of about 10 inches. The subsoil is a gray or drab heavy loam to silty clay which is occasionally mottled with yellow and red in the lower depths. When dry the surface is loose and easily cultivated, but it is apt to become quite sticky when thoroughly saturated. As a rule, the surface soil contains somewhat more organic material than is found in the other soils of the area, being sufficient in some of the wetter bodies to give the type a pronounced black appearance.

The Myatt fine sandy loam occurs as low, flat land from one-fifth mile to 2 miles in width along nearly all the streams in the southern half of the county. The most extensive bodies are found in the vicinity of Georgiana and Dunham along Persimmon, Rocky, Panther, and Long creeks. The type is also found in the southeast part of the county along Pigeon Creek and its larger tributaries. The Myatt fine sandy loam is an alluvial soil of recent origin laid down by the overflow waters of the streams along which it occurs.

A large proportion of the type is still covered by a native growth of gum, cypress, loblolly pine, beech, and magnolia. In its present wet condition it is a rather late soil, but if properly drained it would be well adapted to the production of small fruits and truck, as well as to a variety of grasses and forage crops.

Cotton and corn are grown on the type, the former yielding from one-fourth to 1 bale per acre, with an average of one-half bale, and the latter from 12 to 25 bushels per acre, with an average of about 16 bushels. On account of the wet condition of the land in spring ridge cultivation is used for both cotton and corn.

Located along streams and having a level topography, the drainage of the type is poor and much of it is subject to overflow. Artificial drainage, however, could be cheaply provided by the construction of open ditches and a few inexpensive dikes.

Probably not more than 1 or 2 per cent of the type is under cultivation and its value ranges from \$3.50 to \$7.50 an acre.

The average results of mechanical analyses of this soil type are given in the following table:

Mechanical analyses of Myatt fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16343, 16346..	Soil.....	0.4	0.7	1.7	19.2	20.3	49.7	7.9
16344, 16347..	Subsoil.....	.1	.7	.9	16.7	18.9	43.9	18.4
16345, 16348..	Lower subsoil..	.1	.4	.9	13.8	18.5	43.3	22.4

HOUSTON CLAY.

The soil of the Houston clay consists of heavy clay loam or clay about 3 inches deep, varying in color from dark gray or drab to black. The subsoil is also a drab or black waxy clay resting on a bed of loose, rotten limestone at from 5 to 20 inches below the surface. As this limestone is approached the dark, sticky clay gives place to a white, chalky material, which when dry breaks down into an impalpable powder. When wet the material is extremely sticky and plastic. At about the second foot it begins to solidify and at 3 feet deep is usually a consolidated bed of limestone. Throughout the type frequent ridges are found strewn with fragments of the broken rock, which in places become so numerous as to interfere with cultivation.

The Houston clay is confined to a few square miles in the north-western corner of the county. Beginning well up on the steep slopes which border Wolf and Cedar creeks, the type extends down to the rich, alluvial soils in the bottoms. Usually after the first steep slopes of the gullied hillsides are passed, the land becomes more gently rolling and almost level areas are occasionally found.

The Houston clay owes its formation to the weathering of the Cretaceous limestone, which it immediately overlies. About 80 per cent of the type in Butler County was originally covered by a valuable growth of red cedar, but most of this has already been removed and a young growth of the same species has since taken possession of the soil. The remaining 20 per cent is a level or gently rolling prairie, of which not more than 10 per cent is under cultivation.

The Houston clay is well adapted to grasses. During the last few years Johnson grass has been grown for hay and is proving to be a

valuable crop. Three cuttings are usually secured each season, yielding from one-half ton to 1 ton per acre at each cutting. The hay, which sells for about \$15 a ton baled, is considered more profitable on this soil than either cotton or corn. The great objection to this grass crop is that it spreads rapidly and is difficult to eradicate in case the land is needed for some cultivated crop. With the exception of a few small bodies of Meadow along Wolf and Cedar creeks the Houston clay is by far the best alfalfa soil in the county and could be made to produce this crop with profit. Both cotton and corn are grown to some extent, though they are said to rust badly after being cultivated a few years on this soil. From one-half to two-thirds of a bale of cotton and from 18 to 30 bushels of corn per acre are the usual yields.

The land is naturally strong and productive, yet, owing to distance from market facilities, its rough, stony surface, and the difficulty of securing labor, only a small percentage of it is under cultivation. The average price of the type is about \$10 an acre.

The results of mechanical analyses of fine-earth samples of the soil and subsoil of the Houston clay are given in the following table:

Mechanical analyses of Houston clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
15507.....	Soil.....	0.7	5.9	5.1	16.3	16.7	22.1	33.1
15508.....	Subsoil.....	.9	3.0	3.0	15.7	12.9	41.4	23.3

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 15508, 0.68 per cent.

SUSQUEHANNA CLAY.

The Susquehanna clay consists of 1 to 5 inches of fine gray sand overlying stiff, red clay, which becomes mottled in the lower depths. The sandy covering is rarely more than 3 inches deep and in places is entirely absent. Owing to the plastic, waxy nature of the subsoil and its nearness to the surface, the type is very refractory and difficult to cultivate.

Only a few comparatively small areas of Susquehanna clay are found in Butler County. The principal areas occur north of Cedar Creek and in the central part of the county between Butlersprings and Bolling. The type is also found near Rhodes Siding, on the Alabama and Florida Railroad, and in the vicinity of Pigeon Creek and Oak Streak.

Except in the central and western parts of the county, where the type occupies level plateaus, the topography is rough and hilly. On the hilly areas the surface drainage is good, but the level bodies are frequently too wet for cultivation for several days after heavy rains.

The Susquehanna clay is of sedimentary origin, being derived from water deposits in the Eocene age at a time when the water was deep and quiet. The sandy covering represents a much more recent deposit, which in most places was considerably deeper than at the present time. The native vegetation is largely longleaf pine, red oak, white oak, and post oak.

Owing to the difficulties encountered in the cultivation of such a stiff, plastic clay, the type is not adapted to a wide range of crops. Grasses should do well if care be taken to get them established. Cotton and corn are the only crops grown, but both are said to rust when cultivated on the same land for two or three years in succession. Because of the tenacious character of the clay the land is difficult to plow, and the preparation for the seed as well as subsequent cultivation is not as thorough as it should be. For this reason the yields are low, which fact has given rise to the belief that the soil is naturally unproductive. Instances, however, are reported where gratifying results have been secured through thorough cultivation.

In many sections the land was originally occupied by valuable forests of pine. In most cases the larger timber has been removed and a dense second growth of longleaf pine has taken its place. These forests will soon become of value, and as there is still a large acreage of idle land in the county more desirable for cultivation, it is doubtless best to leave these wooded areas of Susquehanna clay in forest. Not more than 1 or 2 per cent of the entire type is under cultivation.

The value ranges from \$2.50 to \$12 an acre, depending on location and timber growth.

The results of mechanical analyses of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Susquehanna clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
15509.....	Soil.....	0.8	2.5	3.8	44.8	8.7	13.4	25.8
15510.....	Subsoil.....	.3	1.4	1.9	22.3	6.2	11.4	56.5

SUSQUEHANNA FINE SANDY LOAM.

The Susquehanna fine sandy loam, from 5 to 15 inches, consists of gray or brown fine sand or light fine sandy loam, underlain at an average depth of about 10 inches by a stiff red clay, which is usually mottled with yellow and gray below the second foot. Much of the type rests on a bed of rotten limestone from 2 to 10 feet deep, of which fragments are frequently found scattered over the surface and mingled

with both soil and subsoil. These, together with the stiff plastic nature of the subsoil, make the type a rather difficult one to work.

The Susquehanna fine sandy loam is the most generally distributed soil in the county, occupying about 30 per cent of the total area. It occurs in all parts of the county, the largest bodies being found between Butlersprings and Georgiana, and to the east of Bolling. Areas are also found in the vicinity of Oaky Streak, Pigeon Creek, and in the northeast corner of the county.

A phase of the Susquehanna fine sandy loam consists of a gray fine sand 12 inches deep, underlain by reddish-yellow, stiff, waxy clay. Below this occurs a stiff, mottled red, yellow, and gray clay, which bakes and cracks when exposed to the sun. This phase is found in the vicinity of Georgiana in comparatively level tracts, and in appearance somewhat resembles the Norfolk fine sandy loam.

The surface features of the Susquehanna fine sandy loam are varied. In the vicinity of Wolf and Cedar creeks, where the streams have cut from 50 to 150 feet below the surrounding country, the topography is rough and broken. Rugged areas are also found in the southeastern part of the county in the vicinity of Oaky Streak and along the east bank of Pigeon Creek. The greater part of the type, however, is level or gently rolling.

As a rule the surface drainage is good, but the structure of the impervious clay subsoil is such that the absorption of water after heavy rains is usually very slow. For this reason ditching would be beneficial on the level areas. In the hilly section about Cedar Creek the subsoil contains a high percentage of mica and the steep slopes are badly gullied.

The Susquehanna fine sandy loam is a sedimentary soil derived from the weathering of marine deposits. In places the underlying beds of Cretaceous limestone come very near the surface and have contributed to some extent to the formation of the soil. The native vegetation is chiefly longleaf pine, red oak, white oak, and hickory.

The Susquehanna fine sandy loam if well drained is adapted to a wide range of crops. Cotton and corn, however, are the only crops grown, the former yielding from one-third to three-fourths bale, and the latter from 15 to 25 bushels per acre. The grasses and fruit should do well. The plowing is very shallow and ridge cultivation is practiced for both cotton and corn. Both of these practices favor washing and add to the natural tendency of the soil to dry out during the growing season. The greatest needs of the type are deeper plowing, more frequent and shallower cultivation, and the addition of humus to the soil.

Only commercial fertilizers are used, the most common being cotton seed, or cotton-seed meal, acid phosphate, and kainit. From 200 to 300 pounds per acre is the usual amount applied.

Only about 10 per cent of the Susquehanna fine sandy loam is under cultivation, a fact which is partially accounted for by the distance of the type from shipping points or markets. The value of land of this type ranges from \$5 to \$15 an acre.

The average results of mechanical analyses of samples of the soil and subsoil are given in the following table:

Mechanical analyses of Susquehanna fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16371, 16373.....	Soil.....	0.4	1.7	1.7	29.2	39.8	21.1	6.0
16372, 16374.....	Subsoil.....	.1	.3	.3	10.7	21.3	17.6	49.3

OCKLOCKNEE CLAY.

The Ocklocknee clay consists of 2 to 6 inches of gray or mottled gray and orange silt loam, resting on a subsoil of mottled gray and yellow clay. When wet the soil is sticky and plastic, but it becomes hard and compact when exposed to the sun.

The type is unimportant in Butler County, being found only in small areas on the lowlands near the southern county line. Only four small bodies occurring as narrow strips along Pigeon Creek appear on the map. Other areas of a few acres in extent may be found along nearly all the larger streams in the southern part of the county.

The Ocklocknee clay occupies the lowest position in the bottom and is subject to frequent overflow. It is covered by a dense growth of loblolly pine, white oak, cypress, gum, and magnolia. In its present condition the land has a low agricultural value. It is held at from \$2.50 to \$5 an acre, depending entirely on the timber growth.

The results of mechanical analyses of the soil and subsoil of the type are given in the following table:

Mechanical analyses of Ocklocknee clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16337.....	Soil.....	0.0	1.0	0.4	9.5	5.9	50.5	32.3
16338.....	Subsoil.....	.2	.3	.4	7.3	9.3	33.5	48.5

MEADOW.

The Meadow in this county consists of low-lying areas in which textural variations occur so frequently that detailed classification is impracticable. The texture of the soil varies from light fine sandy loam to the heaviest clays of the area.

The most important phase consists of heavy black clay, 3 feet or more in depth, which occurs in the northwest corner of the county in a number of small areas throughout the bottoms of Cedar, Wolf, Muscle, and Saddlers creeks. Alongside of these clays are found soils varying from sand to heavy silt loam, though no soil of uniform texture occupies sufficient area to appear separately on the map.

The other phases of Meadow consist of light-colored sands several feet deep, containing varying amounts of silt and clay. The largest bodies occur along Pigeon, Three Run, Halls, Persimmon, Mill, Breastwork, and Pine Barren creeks.

Owing to the level topography and low position along the streams, the soil is subject to overflow at all seasons of the year. The water, however, rarely covers it more than two or three days at a time and, as a rule, cultivation is possible without artificial drainage, though ditching would be beneficial on the lower areas. On the heavy phase along Cedar Creek much of the land has been protected from overflow by the construction of ditches and dikes, and where this has been done its value has been greatly increased.

Meadow is an alluvial soil deposited by the streams in times of overflow. Along Cedar, Wolf, and Muscle creeks the soil is composed of fine material washed down from the highlands of Houston clay. In the eastern and central parts of the county it consists of sands and silts washed from the adjoining sandy types. Where uncultivated, the soil is occupied by bay, gum, cypress, beech, loblolly pine, white oak, and holly.

Owing to the wide range of textural conditions, the areas are adapted to a large variety of crops. For the production of cotton, corn, sugar cane, and grasses the Meadow is unsurpassed by any soil in the county. If properly drained, it would be in many cases an excellent soil for alfalfa, though this crop as yet has not been introduced.

The yields of cotton range from one-third bale to $1\frac{1}{2}$ bales per acre, with an average of about three-fourths bale; corn from 20 to 35 bushels, with an average of 30 bushels, and when sugar cane is grown from 250 to 500 gallons of sirup per acre are produced. As the land is naturally productive, only small quantities of commercial fertilizers are used.

In the northwestern part of the county, where the land is heavy, about 90 per cent of the Meadow is under cultivation, and its value ranges from \$10 to \$30 an acre. On the sandy phase a much smaller proportion has been cleared, and such land commands only from \$5 to \$10 an acre.

SUMMARY.

Though the majority of the farmers of Butler County still follow the one-crop system, the recent introduction of trucking has brought about a great diversification of crops in some sections and is having a general salutary effect on the agriculture of the county. The truck grown is of splendid quality and brings good prices in the northern markets.

A closer study should be made of the adaptation of soils to crops. Plowing should be deeper and cultivation more frequent and shallower. Organic matter should be added to the soils and more leguminous crops should be grown and turned under with this end in view. Cotton seed, instead of being sold and removed from the farm, should be returned to the land as a fertilizer.

The value of most of the farm lands in the county ranges from \$4 to \$10 an acre, though a few of the most desirable farms near Greenville and Forest Home are held as high as \$100 an acre.

To prevent erosion of lands most subject to this waste, the plowing of some fields should be discontinued and the lands should be seeded down and used for pasture. In such case more stock should be kept.

The soils of Butler County are varied. Sixteen distinct types were recognized and mapped.

The Orangeburg fine sandy loam is considered one of the most desirable soils in the county. It is early and productive, and responds well to good cultivation and fertilization. It is especially adapted to peaches, berries, radishes, onions, Irish potatoes, and a high grade of Cuban filler tobacco.

The Susquehanna fine sandy loam, the most extensive type in the county, is adapted to a wide range of crops, chief among which are cotton, corn, grasses, and fruit.

The Norfolk fine sandy loam is adapted to late truck and probably to bright yellow tobacco. Grasses also do well on the low areas, which should furnish excellent pasturage. Some of the low areas would be benefited by artificial drainage.

The Norfolk fine sand is a typical trucking soil, being especially adapted to the lighter truck crops. The soil is in need of humus, which should be supplied by the turning under of leguminous crops.

The Norfolk sand is a deep, coarse-textured sand, occurring chiefly in the northwest part of the county. Where favorably located as regards markets, it is adapted to melons, truck, and small fruits.

The Orangeburg fine sand is a loose, incoherent sand, adapted to peaches, melons, tomatoes, and other early truck, as well as the staple crops of the area. The soil is somewhat deficient in organic matter, but retains moisture fairly well. Green manuring would greatly increase its productiveness.

The Orangeburg sand is only moderately productive. It is well adapted to peaches, berries, melons, all early truck, and cigar-filler tobacco.

The Orangeburg sandy loam is a coarse-textured soil, but if well fertilized is productive and adapted to a variety of crops. Peaches, small fruit, and early truck should prove profitable on the portions of this type lying near a shipping point or close to local markets.

The Orangeburg clay is of small extent in Butler County. It is well adapted to cotton, corn, peaches, pears, and small fruits, and is one of the best soils in the county for the production of a high-grade cigar-filler tobacco. The soil dries out quickly, and needs organic matter and deeper plowing to conserve moisture.

The Houston clay, the heaviest soil in the county, is well adapted to tame grasses and, with the exception of a few small bodies of Meadow along Wolf and Cedar creeks, it is by far the best alfalfa soil in the county. This crop should be introduced by farmers owning this type of soil.

The Susquehanna clay is a stiff, refractory soil of comparatively small extent. It is adapted to grasses and stock raising. Much of the type supports valuable young forests of second-growth longleaf pine, which in most cases should be allowed to mature.

The Myatt fine sandy loam in its present wet condition is a rather late soil, but if properly drained would be adapted to small fruits and truck, as well as a variety of grasses and forage crops.

The Myatt fine sand is a poorly drained soil occurring along streams. If artificially drained, it would be adapted to truck and small fruit.

Meadow is a soil of varying texture found as low, narrow strips along streams. The type is subject to overflow, and is very little cultivated. When drained and protected from floods, it is a valuable soil for the production of cotton, corn, sugar cane, and grasses. On the heavy phase in the northwest corner of the county alfalfa should be introduced.

SOIL SURVEY OF OKTIBBEHA COUNTY, MISSISSIPPI.

By W. E. McLENDON and LEWIS A. HURST.

DESCRIPTION OF THE AREA.

Oktibbeha County is situated in the eastern part of the State of Mississippi. It is included between the parallels 33° 15' and 33° 35' north latitude and the meridians 88° 30' and 89° west longitude. On the north it is bounded by the counties of Clay and Webster; on the east by Webster and Lowndes; on the south by Noxubee and Win-

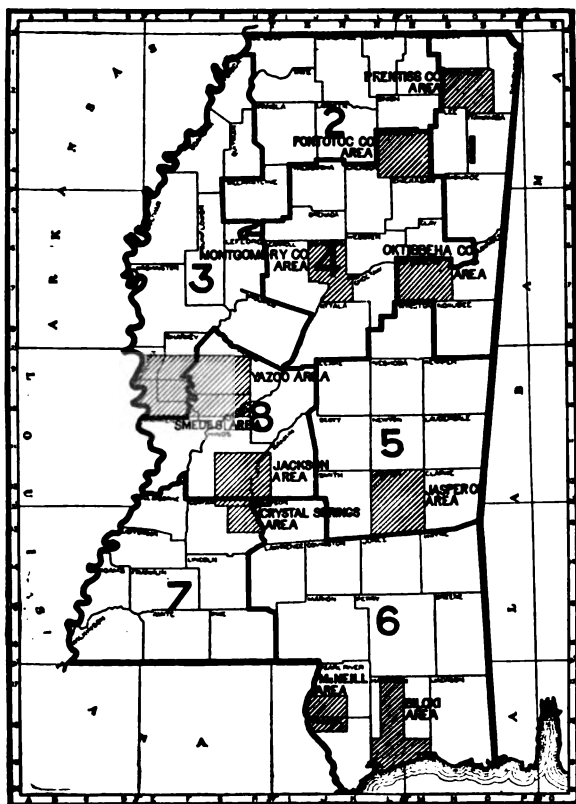


FIG. 15.—Sketch map showing location of the Oktibbeha County area, Mississippi.

ston, and on the west by Choctaw and Webster. The county is in the shape of a rectangle 19 miles north and south by 24 miles east and west, including twelve full Congressional townships and the lower tier of sections of the four townships on the north. The third

standard parallel north forms the southern boundary of the county. The total area of the county is 285,568 acres, or about 446 square miles.

The county is crossed by three physical divisions differing in topography and soils. In general they follow geological boundaries. The eastern third of the county is in the limestone or chalk belt. Streams are numerous and the surface features range from moderately rolling to hilly. The streams have bottoms from a few rods to more than a mile wide, depending, of course, upon the size of the streams. A peculiar feature about the topography, which is also developed to a less extent farther west, is that the stream bottoms are bordered on the south by high broken bluffs and rolling areas, and on the north side by comparatively level lands not much above the bottoms. The broken areas soon give way to high rolling lands which slope and become more level gradually toward the next stream course on the south.

Along the western edge of the county is a strip of high hill lands sometimes referred to as the "red hill section." These hill lands, for the most part, represent the eastern extension of the drainage divide between streams flowing east into the Tombigbee River and those flowing west into the Pearl River. The nine sections in the southwestern corner of the county range from hilly to broken, with local differences in elevation of 100 to 200 feet.

Between the two belts described above is a broad area known locally as the "flatwoods." The surface features throughout this region range from level to gently rolling, except in the broken strips bordering the streams on the south. Small lateral streams here are much less numerous than in the chalk belt or in the high hill lands.

The county has an extensive system of drainage which is very largely to the east across the different geological formations. A narrow strip along the western edge extending 8 miles south from Maben drains to the west. Noxubee River, the largest stream, flows along the southern edge of the county. Its principal tributaries in the county are Sand, Cypress, Talking Warrior, Hollis, Shaw, Browning, and Rocky Bottom creeks. These drain a strip from 6 to 10 miles wide. The central-eastern part of the county drains to the east through Catalpa, Sand, Ash, Ittobechei, Okahatta, and Red Bud creeks. Line Creek, the next largest stream, comes into the county for a short distance near the northeastern corner. The northwestern part of the county is drained by Trim Cane Creek and its tributaries, Sun, Biba Wila, Lick, and Self creeks and a few other smaller streams. Trim Cane Creek, which flows almost centrally halfway across the county, turns to the northeast and passes out of the county about 7 miles from the northeastern corner. All of the streams except Line Creek and Noxubee River dry up occasionally. Oktoc Creek

is what was the Noxubee River before the connection was established across to the bed of Cypress Creek.

The Government surveys were made in the years 1832, 1833, and 1834. Oktibbeha County was organized in 1833 and the court-house was established at Starkville in 1834. Some settlements were made in the county before the beginning of the Government survey. The settlers came largely from North Carolina, South Carolina, and Virginia. The sandy lands in the western part of the county were settled by white people in very moderate circumstances. They never owned any slaves and have always farmed on a limited scale. The flatwoods belt has always been sparsely settled, except in a few neighborhoods. Within the last few years more people have begun farming in this belt. In the eastern half of the county a different order of things has prevailed from the early settlement. The land has been held and farmed in large plantations. The landlords' homes were good, substantial buildings. Since the civil war the white people have gradually moved away from the farms, and many of the old homes have gone to ruin. A great deal of the land is now tenanted by negroes. Large tracts have been thrown out of cultivation and allowed to grow up in pine or else to be ruined by erosion.

Starkville, with a population of about 2,000, is the largest town. It is 4 miles northeast of the center of the county. Maben, in the extreme northwestern corner, has a population of about 800, and Sturgis, near the southwestern corner, has a population of about 300. The smaller towns and railroad stations are Longview, Bradley, Sessums, Osborn, and Muldrow. The Agricultural and Mechanical College of Mississippi is $1\frac{1}{2}$ miles east of Starkville.

Oktibbeha County is passed on three sides by as many main lines of railroad at a distance of 1 to 3 miles beyond its borders. The Mobile and Ohio Railroad parallels the eastern boundary; the Southern Railway the northern boundary; and the Mobile, Jackson and Kansas City Railroad the western boundary. The Southern comes into the county for a short distance at Maben. The Aberdeen branch of the Illinois Central Railroad traverses the county almost centrally in a general northeast and southwest direction. A branch line of the Mobile and Ohio enters the county from the east, terminating at Starkville. All of these railroads give the county fairly good shipping facilities. They occur in such way, however, as to lead a great deal of the local business outside of the county.

Some of the main public roads are almost impassable during wet weather and especially during the winter months. A great deal could be done to improve these roads at small expense.

The bulk of the cotton crop is marketed at Starkville and other local points. At Starkville is a cotton factory, a cotton-seed oil mill, and a large warehouse for storing cotton.

CLIMATE.

The climatic conditions of Oktibbeha County are quite similar to those over a large portion of the cotton-growing States. The summers are long and warm enough to allow the successful growth of a variety of crops. The winters are mild, except for occasional cold snaps of relatively short duration.

The following tables were compiled from records of weather bureau stations at Columbus and Louisville, both of which are in adjoining counties.

Normal monthly and annual temperature and precipitation.

Month.	Columbus.		Louisville.		Month.	Columbus.		Louisville.	
	Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.		Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.
	<i>°F.</i>	<i>In.</i>	<i>°F.</i>	<i>In.</i>		<i>°F.</i>	<i>In.</i>	<i>°F.</i>	<i>In.</i>
January.....	44.2	4.77	45.1	5.68	August.....	81.9	4.39	79.4	4.68
February.....	44.6	5.00	47.9	5.12	September...	76.1	2.55	74.4	2.56
March.....	53.8	7.00	55.1	6.16	October.....	68.9	2.06	64.0	1.68
April.....	62.2	4.77	62.9	4.24	November....	58.7	3.17	58.9	3.05
May.....	72.8	3.16	70.5	3.12	December....	46.6	4.87	47.4	4.63
June.....	81.3	4.76	77.0	4.39	Year.....	68.7	52.10	68.1	50.49
July.....	83.2	5.60	79.7	5.01					

Dates of first and last killing frosts.

Year.	Columbus.		Louisville.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1898.....	Apr. 7	Oct. 27	Apr. 7	Oct. 23
1899.....		Nov. 4	Apr. 10	Nov. 3
1900.....	Apr. 1	Nov. 9	Apr. 1	Nov. 10
1901.....		Nov. 6	Mar. 21	Nov. 18
1902.....		Oct. 28		Oct. 29
1903.....		Oct. 25	Mar. 25	Oct. 25
1904.....	Mar. 29	Oct. 23	Mar. 28	Oct. 23
Average.....	Apr. 2	Oct. 31	Mar. 31	Oct. 31

It will be observed from these tables that the annual precipitation is slightly over 50 inches. This is fairly well distributed through the growing season, the drier weather of the autumn months being favorable for gathering crops. The heaviest rainfall is in March. For Louisville the average dates of the last killing frost in spring and the first in fall are given as March 31 and October 31, respectively. Occasionally frost occurs late enough in the spring to injure tender crops.

AGRICULTURE.

The agricultural development of Oktibbeha County has been mainly along the lines common over a large portion of the cotton-growing

States. The soils and climatic conditions are very favorable to a wide variety of agricultural interests, but since the early settlement of the area there has been an increasing disposition to grow cotton as the chief money crop. Especially has this been noticeable since the civil war. The farmers turned their attention to such crops as would command a ready market and a good price. Cotton proved most attractive for this purpose. As the acreage of cotton was gradually increased less attention was given to the many necessities for home consumption, including corn, oats, forage, pork, beef, potatoes, etc. This system of farming is now followed by a majority of the landowners as well as by the tenants.

Before the civil war there were two general systems of farming in the county. The limestone belt, comprising roughly the eastern third of the county, was held in large estates, which were farmed with slave labor. These old slave plantations were well kept, and their owners usually were very prosperous. Through the sparsely settled flatwoods belt and on the sandy lands in the western part of the county the farms generally were not so large, and most of them were operated by the owners. The effect of the war on labor conditions here is less noticeable than in the eastern part of the county, as most of the farming element consists of white people, and only a few of the farms are tenanted. The farmer and his family do most of the work. Through the limestone belt, on the other hand, the bulk of the land, while still held by whites, is tenanted by negroes, in tracts ranging from 20 to 90 acres. This system of tenanting has led most of the white planters to move to the towns and cities.

The agricultural conditions in the county have improved a great deal within the last ten years. Farmers who have been purchasing their supplies on a lien every year and living under mortgages are now out of debt and many of them have at least a small bank account. There are also evidences that they are improving their home surroundings. In the western part of the county some of the houses have been enlarged recently, and there are some new houses. To make much further headway in improving the agricultural conditions it will be necessary for the landowners to realize the importance of improving the methods of tillage and cultivation. Lands once allowed to run down and be ruined by erosion are approaching very closely a state of worthlessness. The tenants generally pay their rents and liens for supplies with cotton, but it would be a wise plan to encourage them to grow a running supply of corn and other things they can produce cheaply for home use, and above all to encourage them to practice better cultural methods so as to keep the soil in a state of higher productiveness. Immediate returns may be attractive, but there is little profit in the long run in renting lands if they are to be farmed in such a way that their intrinsic value constantly diminishes. Care-

less methods are very largely responsible for the many raw clay hills through the eastern end of the county, which, though once very productive lands, are now of little agricultural value.

Cotton is the all-important crop, and no doubt it will continue to be so for many years to come. However, there is a growing opinion that the salvation of the section lies in diversified farming. A few farmers in the limestone belt have begun producing hay for market, and are finding it very profitable. The grasses chiefly grown for this purpose are Bermuda and Johnson grass. The farmers, as a rule, are prejudiced against these grasses because they often prove very serious pests in the cotton and corn land through the limestone belt. At the time of the survey a few areas were in alfalfa, which was doing well. This is one of the promising crops for the dark-brown and black calcareous upland clays, as well as on the well-drained bottom lands, and it will receive much more attention in the future. A few of the farmers through this section have profitable dairy herds. Not a great number of beef cattle are marketed, and they are mostly of nondescript breed picked up here and there among the farmers. There seems to be no reason why stock raising should not be extended. Very little has been done in the line of fruit growing, which doubtless would prove profitable on some of the soils of the county. Some peach and plum orchards have recently been set out on the Oktibbeha fine sandy loam and the Oktibbeha clay. The Orangeburg fine sandy loam is one of the best peach soils of the section, but it is not being used at all for this purpose. The orchards for home purposes are usually small.

An idea of the relative importance of the different crops grown can be had from the Twelfth Census, which reports the conditions for the year 1899. According to this authority 36,946 acres were in cotton, producing 13,350 bales; 32,082 acres in corn, producing 587,150 bushels; 1,286 acres in oats, producing 15,590 bushels, and 1,158 acres in grasses for hay, producing 1,165 tons. The crops of lesser importance enumerated were sweet potatoes, sorghum cane, sugar cane, peas, clover, peanuts, and miscellaneous vegetables. The value of the orchard products was placed at \$8,229, and of forest products at \$46,686. At the present time cross-ties form a very important part of the output of the flat-woods belt and of the sandy hill lands to the west of the flat woods. The value of the farm live stock was given as \$618,648. The total value of the products of the farm not fed to live stock was \$1,075,212.

It will be seen from the above figures that the average yield of cotton is a little more than one-third of a bale and the average yield of corn about 18 bushels per acre. These averages include all types of soil, but even with the poorer types included it is safe to say that the yields of these, the most important crops of the area, could be

doubled by more thorough methods of tillage and cultivation. A great deal more could be accomplished simply by substituting larger plows and other modern machinery for the light one-horse plows now in general use.

In preparing land for cotton, where cotton follows cotton, as it very often does, a common practice is to run a center furrow in the middle of the old rows, then bed over this with a light turning plow, throwing one or two furrows from each side. This puts the land in shape for planting. Very few break their land broadcast, and where this is done the plowing usually is not more than 2 or 3 inches deep. The planting is done with different styles of cotton planters, most of which drill the seed instead of dropping a certain number of seeds at desired intervals. Most of the planting is done on ridges or beds. The rows are from $3\frac{1}{2}$ to 4 feet apart. If the cotton gets very grassy before it is large enough to thin, a great many "bar off" the rows and leave them that way until the thinning is done. This leaves a narrower strip to be hoed, but the practice is hardly a commendable one under any circumstances. The thinning is followed by a cultivation with a small sweep running close up to the cotton on each side. The after cultivation is done mostly with sweeps which require passing three times in a single row to complete one cultivation. The crop is laid by some time in July, before the bolls have started to mature. An occasional shallow furrow or two through the middle would prove very beneficial during dry seasons up to the time the cotton begins to open. As it is, the crop very often suffers unduly for moisture, and many of the squares fall off that otherwise would develop into productive bolls. A better plan of planting cotton is to break the land broadcast to a depth of 6 or 8 inches, harrow it to a good tilth, then plant the cotton on the level. It is easier to cultivate and to keep down grasses and weeds under this plan than where ridge cultivation is practiced.

The corn crop is planted in a number of ways. In the bottoms it is generally planted on beds so as to give all the drainage possible. More thorough preparation and more frequent cultivation are changes to be suggested. The practice of pulling the fodder is generally followed.

Only a few of the broader soil adaptations are recognized, and these are followed in an irregular way. Although cotton is grown on every type of soil in the county, there is a tendency to confine the corn crop to the better spots of uplands and to the fertile alluvial bottoms. The occasional overflows do not injure corn nearly so badly as they do cotton. And, too, alluvial lands make a fairly good crop of corn most every year.

Very little attention is given to the rotation of crops. This is of prime importance in keeping the soils in a productive state and will

naturally follow diversification. Cotton may follow cotton for a number of years. This practice is one of the causes for declining yields on the once very productive upland areas. Especially is this true in the case of the Oktibbeha fine sandy loam, which, when brought under cultivation, produces good crops of cotton, corn, oats, and grasses. Very few farmers grow cowpeas as a means of improving the soil. Clover does not do well beyond the limestone belt, but cowpeas will make a good growth on any of the soils that are properly drained.

No commercial fertilizers are used, except on some of the sandy lands in the western part of the county. The census reports cited above gave \$990 as the amount paid out for fertilizers in the year 1899. In the use of commercial fertilizers, which on some of the thinner soils, no doubt, would prove profitable, it would be well for the farmers to get the Mississippi agricultural experiment station to make some tests to determine just what fertilizers are required and what amounts could best be used.

There is a general scarcity of satisfactory labor in the area. The majority of the negroes would rather rent a small farm than work for wages. Day laborers are usually paid from 50 to 75 cents, and as much as \$1 a day is paid for some kinds of work. Regular help costs from \$10 to \$12 a month, with board or rations. Cotton is picked at so much per hundred pounds. In the year 1899 a total expenditure of \$35,550 was paid for labor in the county.

The census of 1900 reports 207,895 acres in farms in the county, a little more than half of which is improved. The average size of the farms is given as 65.7 acres, but each tenancy, containing from 20 to 75 acres, was enumerated as a farm, and thus the size of individual holdings is much greater than the figures reported. There are some holdings of more than 1,000 acres. About 30 per cent of the farms are operated by the owners.

The chief system of tenancy is to rent from 20 to 30 acres of land for each mule or horse worked by the tenant. The tenant furnishes everything but the land and the house. The price ranges from \$75 to \$100, to be paid when the crop is gathered. The few that rent on a cash basis pay from \$3 to \$5 an acre. Nearly all of the tenants carry a lien with the merchants or their landowners for supplies to run them through the spring and summer months.

The land values in the county are still comparatively low. The uplands range in price from \$10 to \$50 an acre and the drained alluvial lands from \$25 to \$50 an acre. As much as \$75 an acre is asked for particularly desirable areas.

As already stated, the great diversity of soils in the county offers an opportunity for a wide range of agricultural interests. The limestone belt could be developed into a first-class dairying section. Another

profitable industry would be the raising of hogs, mules, and horses. The poorer upland here could be used for grazing purposes and the better lands for corn, hay, and other forage crops. The Orangeburg fine sandy loam is a good peach soil, and probably a good tobacco soil. The Norfolk fine sandy loam is a good early truck soil. All of the bottom lands when properly drained will give heavy yields of corn and much of them will produce heavy yields of alfalfa and Bermuda grass. Johnson grass will grow well on any of the productive soils, but it is a serious pest in all of the cultivated land throughout the limestone belt. The Houston clay has proven an excellent alfalfa soil.

In addition to cotton, every farmer should raise a running supply of corn and forage, as well as a number of necessary articles for the table. The plan should be to grow everything needed at home and then produce as much cotton as can be properly handled.

The value of deeper plowing and more thorough cultivation of the crops can not be too strongly urged. Cotton can not make its best development where the roots are confined mainly to a zone 2 to 4 inches deep. A shallow soil does not absorb much of the rainfall unless the subsoil is sandy, and what it does absorb is lost rapidly by evaporation. Shallow plowing also facilitates erosion. Deeper plowing and the practice of a systematic rotation of crops, which will keep up the humus content of the soil, will do much to obviate these circumstances, and where these changes in methods are followed a marked increase in crop production may be expected.

SOILS.

The soils of Oktibbeha County are derived from four geological formations, with a few local modifications from a fifth. The oldest of these formations is the Selma chalk of the Cretaceous period. It appears at the surface in a number of rolling areas and as eroded chalk strips all through the eastern part of the county. A few local areas of the Ripley formation, which is also of the Cretaceous period, are found in this section of the county immediately overlying the Selma chalk. It outcrops very locally.

Beginning just west of Starkville and extending west beyond the limits of the county is a stratum of heavy joint or shaly clay containing considerable lignite. This formation, known as the Lignitic clay, belongs to the Eocene epoch of the Cenozoic era. It forms the surface over a large part of the flatwoods, and the other areas through this belt are underlain by it at a depth of 3 to 6 feet. In the highlands along the western edge of the county it is buried by the Lafayette formation, and this in turn is covered over in places by the Yellow Loam formation. The Lafayette also occurs in the eastern part of the county as remnants on many of the ridges.

A typical section of the Lafayette shows several feet of sandy clay, which usually has a strong red color, underlain by a heavy clay. Over a number of areas only the heavy clay has been left to form the soil. This formation belongs to the Pliocene epoch of the Cenozoic era.

The newest formation is the Yellow Loam of Pleistocene time, which once covered all of the older formations in a layer from 5 to 20 feet deep. Over the Selma chalk it consists of a sandy clay very much mottled in the lower depths. In the flatwoods belt it is more silty and loesslike, and in the region of high sandy lands it ranges from sandy to silty, the predominating color everywhere being a yellow or yellowish brown.

Of the uplands the Selma chalk gives rise to the Houston clay and the chalky eroded areas mapped as the Houston chalk; the Lignitic clay to the Lufkin clay and a few local spots of the Susquehanna clay, and the Lafayette formation to the Orangeburg and Norfolk fine sandy loams and the Orangeburg clay. The heavy clay layer underlying the Lafayette, referred to above, gives the Susquehanna clay in the eastern part of the county and the Susquehanna silt loam and a few local areas of the Susquehanna clay in the western part. The Yellow Loam formation gives different soils in different parts of the county. In the limestone belt its typical soil is the Oktibbeha fine sandy loam, the Oktibbeha clay being mostly an erosion type from the fine sandy loam. Local sandy areas were mapped as the Norfolk fine sandy loam. In the flatwoods it gives the Oktibbeha silt loam, most of the Oktibbeha clay loam, and probably the Lufkin silt loam. A few of the chalky areas have been modified by the Ripley marls.

The alluvial soils through the limestone belt vary in texture from a fine sandy loam to a clay, all of which have been influenced by the Selma chalk. The small bottoms, varying from sandy to silty, were mapped as the Ocklocknee loam, the next heavier type as the Catalpa silt loam, and the heavy black clay areas as the Wabash clay. The bottoms through the Lignitic clay belt consist mostly of a loamy clay, which was mapped as the Ocklocknee clay. The influence of the Lignitic clay on this type is easily seen in its color and texture. In the bottoms of Noxubee River and the larger bottoms of Sand and Cypress creeks are a gray loam and a gray clay. These were mapped as the Waverly loam and the Waverly clay, respectively. They represent purely alluvial material brought down from the sandy lands without any influences from the Selma chalk and very little from the Lignitic clay. Along the western edge of the county the small streams, heading in the Susquehanna silt loam and the Orangeburg fine sandy loam areas, have narrow bottoms varying from sandy to silty in texture. Although not influenced by the Selma chalk, they

were grouped with the Ocklocknee loam, the two phases having about the same crop value and adaptabilities. The bottom lands are extensive and play an important part in the agricultural interests of the section.^a

The following table gives the names and areas of the several soil types shown in the accompanying map:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Lufkin clay.....	38,464	13.5	Lufkin silt loam.....	8,704	3.0
Ocklocknee clay.....	32,512	11.4	Oktibbeha clay.....	8,576	3.0
Norfolk fine sandy loam.....	24,832	8.7	Houston chalk.....	8,064	2.8
Ocklocknee loam.....	22,784	8.0	Wabash clay.....	7,616	2.7
Susquehanna clay.....	18,880	6.6	Waverly clay.....	7,360	2.6
Oktibbeha fine sandy loam.....	17,344	6.2	Myatt fine sandy loam.....	6,144	2.1
Oktibbeha clay loam.....	15,360	5.3	Catalpa silt loam.....	5,056	1.8
Orangeburg fine sandy loam.....	14,784	5.2	Myatt clay loam.....	4,096	1.4
Oktibbeha silt loam.....	13,824	4.9	Orangeburg clay.....	1,856	.6
Houston clay.....	10,368	3.6			
Susquehanna silt loam.....	9,984	3.5	Total.....	285,568	
Waverly loam.....	8,960	3.1			

OKTIBBEHA FINE SANDY LOAM.

In its most extensive development the Oktibbeha fine sandy loam consists of 5 to 10 inches of a brownish-gray to light-brown fine sandy loam, grading directly into a rather heavy yellowish-brown sandy clay. The subsoil is not much mottled in the first 2 or 3 feet, but below this it becomes very much so, yellow, gray, and brown colors being intermingled. The soil, in the virgin state, contains enough humus to make it dark and mellow. After having been under cultivation, however, it becomes much lighter colored and develops close, compact structure.

Numerous local variations occur in the type as a result of erosion and different drainage conditions. The subsoil clay is exposed in a number of spots in nearly every field, and some of the higher knolls and ridges have a reddish-brown color. On some of the slopes and about the heads of many of the small streams the Selma chalk is near or at the surface, the result being soils varying in color and texture from the black Houston clay to a fine sandy loam of the same texture as described above. Even the sandier soils, where they have been influenced by the Selma chalk, are dark colored. Another variation occurs along some of the lower slopes where there is con-

^a For a fuller discussion of the geology of the county see Report 1, of the Geological and Industrial Survey of Mississippi, entitled "Geology of Oktibbeha County."

siderable seepage. The soil here, to a depth of 6 to 12 inches, is a gray to dark gray fine sandy loam, containing a noticeable amount of small iron concretions. The subsoil is a gray mottled sandy clay. Larger areas of this character were mapped as the Myatt fine sandy loam. Here and there are also local spots of the same character as the Norfolk fine sandy loam.

This type is derived from a sandy clay known geologically as the Yellow Loam formation. All areas are rolling, and except for local seepage are well drained. The type occurs almost entirely in the eastern third of the county, where the Yellow Loam overlies the Selma chalk. A few small areas were mapped in the northwestern corner of the county.

The original growth consists of oak, hickory, maple, and a few other hardwood trees, oak being the most plentiful.

The area of this type is growing less every year. Under the prevailing methods of tillage much of the surface soil is being washed down into the depressions; hence over what was once good productive fine sandy loam there are now gullied fields and clay hills. A large percentage of the type is under cultivation, though some cleared areas are lying idle. When first cleared it produces heavy yields of cotton, corn, oats, and other crops, but in the older cultivated areas it has been reduced in productiveness to a state where the yields are no longer very satisfactory. Except here and there no commercial fertilizers are used and no efforts are being made to keep the soil in a productive state.

Cotton and corn are the only crops grown to any extent. Cotton yields from one-fourth to one-half bale and corn from 10 to 20 bushels per acre. With more attention to the rotation of crops and tillage much better yields could be obtained. It is not a hard soil to improve. In the line of fruits, peaches, pears, and plums do well.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Oktibbeha fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18914-----	Soil-----	0.4	5.7	4.9	24.8	17.4	33.7	12.7
18915-----	Subsoil----	.3	3.5	2.5	11.9	8.5	39.3	34.0

OKTIBBEHA CLAY.

The Oktibbeha clay consists of a yellowish-brown heavy sandy clay with a depth of 3 or more feet. As in case of the subsoil of the Oktibbeha fine sandy loam, the material becomes mottled as the depth increases, the color being uniform near the surface. Some areas

still have a veneering of the original fine sandy loam covering, while others consist of a raw clay from the immediate surface. Not having much soil to hold water until it can be absorbed by the clay, most of the rainfall flows off the surface. As a result the processes of erosion are increased and the clay remains comparatively dry through a period of wet weather. What moisture is absorbed is lost by capillarity, on account of the compact, homogeneous character of the clay throughout the profile. Crops may actually suffer for water a few days after a rain.

Some of the crests of the ridges where drainage is best have a reddish-brown color. From this there is a gradation in color to a dark dingy brown on some of the slopes, where the Selma chalk comes near the surface. There are also some differences in the texture of the clay. Here and there through the type are local spots of the Susquehanna clay and more rarely spots of the Orangeburg clay. Bordering Susquehanna clay, Houston chalk, and Houston clay areas are often spots and narrow strips of a yellowish-brown heavy clay of about the same consistency as the Susquehanna clay. After long exposure these areas become red. All of the variations of the type may be expected in very local areas.

The Oktibbeha clay is almost entirely the result of erosion in areas that were originally the Oktibbeha fine sandy loam. Its topography is rolling to hilly, and most of the hillsides are badly gullied. It does not occur west of the Selma chalk belt.

As may be inferred, most of the type is or has been cleared. Only a small acreage, however, is under cultivation. The remainder is either pastured or left to grow up in scrub pine, oak, wild plum, etc. The original timber growth was the same as on the Oktibbeha fine sandy loam.

Cotton is the principal crop. The yields are lighter than on the Oktibbeha fine sandy loam. Corn and all other crops of the area give light and uncertain yields. When thrown out of cultivation, grasses, clover, and melilotus do not take to this clay as they naturally would be expected to do. They make a scattering, irregular growth. This condition probably is due to poor moisture conditions rather than to any lack of nourishment in the clay. By plowing deeply and thoroughly and planting to cowpeas or a similar crop for a few years a fairly loamy soil could be built up. Then it would support a good sod of Bermuda grass and be valuable for pasture. When once improved it will also grow good apples and plums, as well as a number of other crops. Its improvement is looked upon by all of the farmers as a difficult problem, for which reason they do not attach much value to the type as a cultivable soil.

OKTIBBEHA SILT LOAM.

The Oktibbeha silt loam consists of 7 to 10 inches of rather sandy yellowish-gray silt loam, underlain by a yellow mottled friable silty clay to a depth of 3 or more feet. Below this the color becomes more a gray mottled with yellow, but the texture remains about the same to a depth of 6 to 8 feet, where a heavy clay is generally encountered. A few very level and slightly depressed areas that were mapped as this type have a gray soil and a gray mottled subsoil, both showing the lack of drainage. The soil in general is deficient in humus and has the appearance of being acid. When under cultivation it clods worse than would be expected of a soil of its soft, friable character.

This soil is derived from a silty phase of the Yellow Loam formation. With the exception of a few small areas in the highlands south of Maben, it forms a part of the flatwoods belt proper. The flatwoods areas are all underlain by the Lignitic clay and the highland areas by a heavy clay that gives rise to the Susquehanna soils where exposed. Two areas were mapped to the southwest of Starkville, between Rabbit Dance and Talking Warrior creeks. The largest body of the type lies to the east and south of Bells. The next largest extends along the Starkville and Maben road, about 8 miles west, beginning at Trim Cane Swamp. Smaller areas occur on the several drainage divides north of Trim Cane Creek.

The surface features of these areas range from level to gently rolling, there being very few drainage ways. The level areas have no surface drainage, and the underdrainage is hindered by the impervious layer of lignitic clay underlying them. This layer of clay also keeps the slopes soggy and wet during and for some time after rainy seasons. On the lower slopes, although gentle, there is considerable seepage.

The timber growth consists of pine, scattering post oak of large size, and a smaller growth of post oak, red oak, and sweet gum. On the wetter areas water-loving oaks are more in evidence.

Under existing conditions this is one of the poorer soils of the county and has never been cultivated to any extent. The few small areas farmed here and there produce light yields of cotton and corn, the two principal crops. No manure or fertilizers are used, and artificial drainage has not been attempted.

Tiling would prove the most effectual way of draining these lands, but open ditches in the depressions and through the flat areas and a few on the slopes to cut off seepage would be of great benefit. Throughout the growing season this can not be regarded as a wet soil, but the trouble is that it stays wet too long after rains. The crops under such conditions will develop a shallow root system and later in the season may actually suffer for water, or if they do develop a deep, extensive root system during a prolonged favorable

season, the roots may later be drowned, the result being an almost or complete failure of the crop. After good drainage has been established cowpeas should be grown extensively to increase the humus content of the soil, and lime should be applied to check any acidity and to increase the power of the soil to hold humus. Coarse manures would prove very helpful, and such lime as is needed could be gotten from the chalk beds of the area. By following this plan good crops can be grown on this soil as cheaply as on any of the light-textured upland soils of the section, for the level surface will permit the use of all kinds of labor-saving machinery. Cotton, corn, and oats ought to succeed, as well as lespedeza and some of the grasses. What the type needs to become valuable land is mainly drainage and more humus.

The following table gives the results of mechanical analyses of the Oktibbeha silt loam:

Mechanical analyses of Oktibbeha silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
10908-----	Soil-----	0.1	1.5	2.3	15.0	2.0	69.1	9.1
16909-----	Subsoil----	.2	1.3	1.9	12.8	5.8	64.5	13.3

OKTIBBEHA CLAY LOAM.

The soil of the Oktibbeha clay loam, from 4 to 6 inches, is a dark-brown friable fine loam or heavy silt loam, containing in most areas a fairly good supply of humus. Cultivated areas generally have a heavier soil than the uncultivated areas, because a small quantity of the underlying clay is plowed up in the breaking and preparation of the land for planting. Under cultivation it is not a hard soil to keep in good tilth. The subsoil is a yellowish-brown silty clay, without much mottling, to a depth of 2½ to 3 feet. Lower down it becomes lighter colored and gives way to the heavy Lignitic clay. The clay subsoil is somewhat heavier and less friable than that of the Oktibbeha silt loam, but it is much more friable and pervious to water than the subsoil of the Lufkin clay.

The Oktibbeha clay loam is confined to the flatwoods or Lignitic clay belt. The largest areas occur in the western tiers of townships about the headwaters of Biba Wila and Lick creeks and of some of the tributaries of Big and Cypress creeks. A number of areas occur farther east. The area just west of Starkville and the one bordering Josey Creek on the west, principally in sections 30 and 31, represent a modification of the type. The soil contains an appreciable amount of fine sand and the subsoil is redder than in the typical areas. Another area of this character borders Hollis Creek on the west.

The type is derived from a thin layer of silty clay immediately overlying the heavy Lignitic clay and probably representing remnants of a heavy phase of the Yellow Loam formation left in the processes of erosion. Some areas seem to be derived from lighter phases of the Lignitic clay formation. The surface features of this soil are rolling enough to allow good drainage, and some of the slopes need to be protected from erosion.

The timbered areas support a thrifty growth of oak, scattering hickory, and pine.

Along with the Oktibbeha silt loam and the Lufkin clay, the Oktibbeha clay loam for a long time was not developed to any extent. Within recent years, however, its value has become more generally recognized, and at the present time over half of the type is under cultivation. Cotton is the chief crop, corn being confined largely to the bottom lands. Oats are grown in a limited way for home use. Cotton yields from one-half to three-fourths bale, corn 20 to 30 bushels, and oats 30 to 50 bushels per acre.

No fertilizers are used. Good wheat crops could be grown on this soil, as well as grasses and other forage crops. It is one of the best upland cotton soils in the county. With good treatment a bale to the acre could be made. All kinds of improved machinery could be used to advantage on most areas.

The following table gives the results of mechanical analyses of the soil and subsoil:

Mechanical analyses of Oktibbeha clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16910-----	Soil-----	1.0	4.3	3.7	18.1	6.7	50.5	15.0
16911-----	Subsoil----	.3	2.1	1.9	8.9	3.4	45.2	37.9

ORANGEBURG FINE SANDY LOAM.

The surface 4 to 15 inches of the Orangeburg fine sandy loam is a gray to brownish fine sandy loam, containing a rather high percentage of silt. This grades rapidly into a red friable sandy clay, which usually extends to a depth of 10 or more feet. On some of the knolls the surface is strewn with small ironstone fragments. These occur to a less extent through the soil and subsoil. The soil proper is from 3 to 5 inches deep, and in most places it does not contain much organic matter.

The Orangeburg fine sandy loam occurs mostly along the western edge of the county, but small areas were also mapped in the eastern half. Most of the Thomson Hills east of Rocky Hill Church is of this type. The surface features range from rolling to hilly and

broken. The Thomson Hills and the area south of Sturgis are very hilly, having local differences in elevation of 100 to 200 feet. Some of the slopes are too steep to be cultivated successfully.

The Orangeburg fine sandy loam is derived from the Lafayette formation, but has been modified to some extent by the material of the Yellow Loam formation. On the slopes local variations occur as a result of exposures of the Selma chalk, the Lignitic clay, and a heavy red clay. These differences occur locally and very irregularly.

The Thomson Hills and the other few areas mapped in the eastern third of the county were originally forested with oak as the principal growth. In the western end of the county the same type supports a mixed growth of oak and pine, both being scrubby in places. Pine is more in evidence on the sandier areas.

Only a small portion of this type is under cultivation. Cotton, the chief crop, does not yield more than one-half bale per acre, except where commercial fertilizers and rough manures are used. The corn yields, too, are light. People farming this soil grow most of their corn on the bottom lands. Commercial fertilizers are used by most of the farmers. With improved methods of farming much better yields should be obtained. Peaches would do well and probably tobacco.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16618, 16620-----	Soil-----	0.0	1.8	4.7	22.1	12.3	51.0	8.0
16619, 16621-----	Subsoil-----	.1	1.0	3.2	18.9	6.9	39.5	30.1

ORANGEBURG CLAY.

The Orangeburg clay is a red, friable fine sandy clay with little or no mottling in the surface 3 feet. The surface few inches varies from a brownish fine sandy loam to a red clay, as left in the processes of erosion.

This type is very limited in extent, although several small areas were mapped in the eastern third of the county and a few to the north and south of Sturgis. These areas prior to clearing were the Orangeburg fine sandy loam. A few timbered areas were mapped, but these were so rolling that the timber growth did not protect them from erosion.

Most of the areas mapped are so badly eroded as to render them unfit for agricultural use. They afford some pasturage during the summer months. The few better areas produce good crops of cotton,

if the land be properly prepared. Such areas as have been eroded beyond redemption should be allowed to reforest themselves.

The Orangeburg clay holds any improvements well, and it is easier to improve than the Oktibbeha clay or the Susquehanna clay.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Orangeburg clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
10022-----	Soil-----	0.1	0.7	4.4	29.4	8.9	29.7	26.9
10023-----	Subsoil----	.0	.8	16.4	32.8	3.4	18.2	33.8

NORFOLK FINE SANDY LOAM.

The Norfolk fine sandy loam consists of 12 to 24 inches of gray to yellowish-gray fine sandy loam, underlain by a yellowish-brown mottled fine sandy clay. The surface 3 or 4 inches varies from light-gray to gray, depending upon the amount of humus present. The subsoil clay of this type is in most places sandier and more friable than that of the Oktibbeha fine sandy loam.

Many small areas of this type occur in the eastern half of the county. They are found mostly on the north side of the streams, where the uplands are lower and less rolling than farther back. Larger areas are found bordering Noxubee River, Sand Creek, Cypress Creek, and Big Creek bottoms.

The areas to the east of Starkville and of Hollis Creek are derived from the sandiest phase of the Yellow Loam formation. They range from nearly level to moderately rolling. Those to the west of Hollis Creek are derived largely from the Lafayette formation, where the surface features are not nearly so rolling as through the Orangeburg fine sandy loam. All areas are naturally well drained except in local spots.

The timber growth on the areas from the Yellow Loam formation consists of oak and other hardwoods. These areas are considered more productive than those from the Lafayette, which are timbered largely with shortleaf pine. Any differences in the productiveness of the two phases are more marked when the land is new, which is to be expected, as oak leaves a soil in a more productive state than pine.

Much less than half of the type is under cultivation and cotton is the chief crop. For the first few years the yields are fairly good, but after this they are very light, unless rough manure or commercial fertilizers are used. Corn does not yield more than 10 to 15 bushels and cotton generally less than one-half bale per acre.

Wherever the railroad can be reached easily this soil offers the best opportunities in growing early truck. It is the type being used so extensively for this purpose along the South Atlantic and Gulf coasts. To grow cotton profitably it will be necessary to practice some system of rotation, so as to keep the soil well supplied with humus. This also applies to the growing of corn.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16904, 16906-----	Soil-----	1.2	4.7	5.7	21.9	4.8	54.3	7.8
16905, 16907-----	Subsoil----	.2	3.6	4.0	15.9	3.5	57.0	15.7

MYATT FINE SANDY LOAM.

The surface 6 to 12 inches of the Myatt fine sandy loam consists of a gray fine sandy loam, more or less streaked with dark iron stains. Most areas have a number of small iron concretions strewn over the surface and also occurring to a less extent through the soil and subsoil. Below 12 inches there is a rapid gradation into a light gray mottled sandy clay. Both soil and subsoil have a closer, more dense structure than is found in the better drained upland areas of the same texture. Although low and wet the soil does not contain more than a moderate amount of humus.

The Myatt fine sandy loam is of limited extent. It occurs in a number of small areas associated with the Norfolk fine sandy loam, the two types being derived from the same formation. The Myatt fine sandy loam, however, includes only the level and depressed, poorly drained areas. Narrow strips at the base of the higher uplands generally are kept wet by seepage, especially during the winter and early spring months. The large areas are so level that water will stand on the surface during wet seasons. The areas in the eastern half of the county are timbered with water oak, pin oak, and other water-loving varieties of this family. The areas farther west support a good growth of pine and a smaller undergrowth of oak.

Only a few small areas are under cultivation. Crops often suffer from the lack of proper drainage. Cotton will yield as much as one-half bale per acre, and corn from 10 to 20 bushels. Fair crops of oats could be grown if good drainage were provided. Lespedeza makes a good vigorous growth. The areas near the railroad, if properly drained, would prove valuable for the production of strawberries. Liming will benefit this soil.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Myatt fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16022-----	Soil-----	1.5	8.0	8.1	25.7	6.9	37.9	12.2
16023-----	Subsoil----	.5	5.2	7.5	19.4	5.6	40.1	22.0

MYATT CLAY LOAM.

The Myatt clay loam, to a depth of 3 to 5 inches, is a brown or brownish-gray silt loam to silty clay loam passing into a light-gray mottled plastic silty clay, which has the appearance of carrying considerable fine sand. The soil under cultivation has a tendency to clod, but with ordinary care it can be reduced to a good tilth.

Only a very small percentage of the area consists of this type. It occurs as low, level areas generally bordering the stream bottoms, and only a few feet above overflow. Parts of these areas bear evidence of once having been a part of the bottoms. A number of small areas are found in the eastern part of the county bordering Sand and Catalpa creeks. The area east of Sessums is a little different from the general run of the type. Being fairly well drained, the soil is brown and the subsoil has somewhat of a yellowish tinge. This area, as well as some of the others along Sand and Catalpa creeks, is timbered with post, red, and Spanish oak, and hickory. The others have a large growth of water, pin and white oak, and hickory, intermixed with scattering pine.

A few areas are cultivated, and except during wet seasons the yields are better than on the lighter uplands. Cotton and corn are about the only crops grown. Oats would do fairly well.

This soil could be made first-class land for a variety of crops if given good drainage, and this can be done at a very reasonable cost.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Myatt clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16024-----	Soil-----	0.0	0.7	1.8	14.0	2.3	61.4	19.6
16025-----	Subsoil----	.0	.6	1.3	12.0	3.1	57.4	24.9

SUSQUEHANNA SILT LOAM.

The Susquehanna silt loam consists of 5 to 8 inches of brown friable silt loam, underlain by a red mottled heavy clay to a depth of

about 2½ feet, then to greater depths by a gray-colored clay of the same texture, mottled with red. The soil contains a fair amount of humus, works up easily, and does not clod to any extent.

Areas of this type are confined to the highlands along the western edge of the county, where in most places the topography is quite rolling. The natural drainage is perfect.

The Susquehanna silt loam is derived from the heavy clay at the base of the Lafayette formation. Ironstone fragments are found to a limited extent throughout the soil and subsoil. Were this to occur in abundance the type would be very nearly the same as the Susquehanna gravelly loam, as mapped in Montgomery County, Ala., except that the soil here is a little finer and the subsoil in most places redder. The two types occur quite similarly and have essentially the same crop value. The silt loam areas, being less stony, are much easier to cultivate satisfactorily.

A large percentage of the type is under cultivation. It is preferred to the Orangeburg fine sandy loam on the one side and the flatwoods clays on the other side. It produces fairly good crops of corn, cotton, and oats. Bermuda grass would afford good pasturage, but little attention is given to the keeping of live stock. Without the use of fertilizers, cotton, where properly cared for, will produce about one-half bale and corn from 15 to 25 bushels per acre. The yields could be greatly increased by the use of manures and more thorough tillage.

The following table gives the results of mechanical analyses of the Susquehanna silt loam:

Mechanical analyses of Susquehanna silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16986.....	Soil.....	1.0	1.5	1.6	11.6	3.3	68.1	12.8
16937.....	Subsoil.....	1.4	2.1	1.2	9.0	3.1	42.1	41.1

SUSQUEHANNA CLAY.

The surface 2 to 4 inches of the Susquehanna clay varies in color and texture from a brownish-gray fine sandy loam to a stiff red clay, the differences being largely the result of erosion since the land was cleared. Nearly all areas had a soil from 4 to 8 inches deep, and some of the leveler areas and lower slopes are still somewhat sandy, but the ridges and steeper slopes are little else than a raw clay to the immediate surface. The subsoil, to a depth of about 3 feet, is a bright red to yellowish-brown heavy clay, mottled to some extent with gray colors. The mottling increases with depth, and below 3 feet the color becomes more nearly a gray mottled with red. When

wet the Susquehanna clay is soft and plastic, but when only moist it is so tough and sticky as to make driving over it very difficult. When dry it makes excellent roads.

This is the most extensive type in the eastern tier of townships. It also occurs in a number of small areas a little farther west and in a few small areas among the hill lands along the western border of the county. The areas in the eastern end of the county are underlain by the Selma chalk at various depths below 3 feet. The chalk outcrops in numerous small spots along the worst eroded slopes. Some of these spots are still chalky to the surface, while some others not now subject to much erosion have weathered into the Houston clay. Such of the latter as are large enough have been shown in the accompanying soil map.

The surface features range from gently rolling to hilly. The area east of Oktoc is decidedly rolling. It is cut by many small streams flowing through narrow V-shaped valleys. Parts of the areas around Muldrow, Osborn, Hickory Grove, and Blackjack, and between Red Bud and Catalpa creeks are only moderately rolling and have a grayish-brown to brown fine sandy or silty loam surface soil 3 or 4 inches deep. The more level areas usually have the yellowish-brown subsoil rather than the red, which is more characteristic of the small spots and larger rolling areas.

The Susquehanna clay is derived from a layer of heavy clay immediately overlying the Selma chalk in the eastern end of the county and the Lignitic clay in the western end. A few of the areas associated with the Lignitic clay soils seem to be derived directly from that formation.

The original tree growth consists of Spanish, post, and red oak, hickory and a few other hardwood species. In some sections it has acquired the name "post oak prairie." Old abandoned areas are growing up to scrubby shortleaf pine, post oak, and blackjack oak.

A large percentage of the type was under the plow before the civil war, but much of the area was subsequently thrown out of cultivation and has suffered severe erosion. At the present time less than half of the type is under cultivation, and the crop yields are generally light. Cotton yields from one-fourth to one-half bale and corn from a nominal quantity to 20 bushels per acre. Very frequently among the tenants 4 to 5 acres are required to produce a bale of cotton.

In the older areas, having practically no soil, or at most only a shallow soil deficient in humus, a large part of the rainfall runs off the surface. The result is that the crops suffer unduly for water and at best have only a very shallow zone within which to develop their roots. A heavy clay with a shallow, light-textured surface soil makes a droughty type for shallow-rooted crops, unless deep plowing and subsoiling is practiced. Even the old worn-out areas that can be

plowed and protected from further erosion can be made into a fairly good soil by plowing deeply and growing cowpeas. After a deep soil has been built up in this way, the fields should be seeded down to grasses for pastures. Bermuda grass would prove excellent for this purpose. By pasturing the uplands and using the bottom lands for corn and other necessary grain and forage crops the Susquehanna clay belt can be changed into a first-class dairy farming section. In this light the present system of growing cotton and a little corn does not pay.

The following table gives the results of mechanical analyses of the soil and subsoil of the Susquehanna clay:

Mechanical analyses of Susquehanna clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16962-----	Soil-----	0.1	1.1	1.8	12.1	8.6	65.6	11.1
16963-----	Subsoil-----	.0	.4	.6	3.6	2.1	46.0	47.0

HOUSTON CLAY.

The Houston clay, or "black prairie," as it is called, to a depth of 9 to 24 inches, is a dark-brown to black loamy clay of a more or less calcareous nature. Some areas are strewn with shells, and all of them have at least a small quantity of lime concretions scattered over the surface and through the soil mass. When wet it is sticky and hard to handle, but when only moist it is sufficiently friable to be easily put in good tilth. Except in local spots, the soil contains an abundance of humus, making it very retentive of moisture. The black clay grades through a few inches into a white or yellowish-white weathered chalk, or into a foot or so of a yellowish highly calcareous clay, and then into chalk. The chalk although weathered considerably still retains some of the original structure of the rock.

This type is derived from exposures of the Selma chalk, which in an unweathered state underlies all areas at various depths below 3 feet. The largest areas occur to the east and south of Osborn in township 19, range 15 east. The next largest area is northwest of Oktoc, along the western edge of township 17, range 15 east. A number of small areas are found all through the eastern third of the county. The larger areas are in general fairly typical of the type as found in the main black prairie belt, but a number of the small areas have a slightly sandy soil, due to a small amount of material left from the Yellow Loam formation which once occupied the entire surface.

As will be seen from the accompanying soil map, the majority of the small areas are at the heads of minor streams and along the slopes.

The surface of these ranges from nearly level to rolling. They are naturally well drained, except for local seepage. The larger areas are gently rolling. Occurring in small areas associated with sandy and red clay lands, this soil was originally timbered with oak, hickory, hawthorn, wild plum, ash, etc.

Nearly all of the Houston clay is under cultivation. Cotton, corn, the grasses, and melilotus make a luxuriant growth. Bermuda grass makes excellent pasturage. A few have tried alfalfa and found that it did exceptionally well when given the proper care. Cotton yields from one-half to 1 bale, corn 20 to 50 bushels, oats 20 to 60 bushels, and hay from one-half ton to 2 tons per acre. A good sod of alfalfa gives about a ton of hay to the cutting.

The Houston clay is a good soil for all kinds of farming except truck and fruit growing. Some areas are still producing good crops after having been under cultivation, and very largely to cotton, for nearly a century. The least productive areas are where the chalk comes near the surface and the soil does not contain a large amount of humus. Such areas should be sown to grass or melilotus.

The type is an exceptionally good one for forage crops, and so offers splendid opportunities for stock raising and dairy farming. Johnson and Bermuda grasses, which are generally considered as pests, would in many instances give better returns than cotton. The possibilities of the type are as yet far from being realized.

HOUSTON CHALK.

The Houston chalk includes exposures of the Selma chalk formation in badly eroded areas, where little or no soil has formed. The surface few inches varies from the bare, partially weathered white chalk to a light-gray or gray chalky loam, depending upon whether erosion is still going on or not. Below this is a white or yellowish-white, partially weathered chalk which usually extends to a depth of 3 or more feet. In some areas the chalk near the surface has weathered to a soft, friable state, while in others it is almost as hard as the blue unweathered rock farther down. Here and there even the blue rock has been exposed. Local spots of the Oktibbeha clay are of common occurrence on nearly all of the ridges and slopes. The areas of Houston chalk in the vicinity of Thomson Hills have been modified in places by sandy marls from the Ripley formation, which occurs in local remnants over the Selma chalk formation. Similar modifications occur elsewhere along the bluff of Trim Cane Creek.

This type occurs as rolling and broken areas about the heads of small streams and along the south bluffs of the larger creeks flowing through the chalk belt. The largest areas extend along Trim Cane and Line Creek bottoms, beginning on the west at Josey Creek. Smaller strips occur similarly along Ash, Sand, and Catalpa creeks. Some areas are pastured, but very few are cultivated, and large

tracts are not used for any purpose. As pasture they are proving valuable, for where there is any soil at all melilotus thrives and the better areas grow good grasses, and lespedeza in addition, all of which are relished by stock. Johnson grass does fairly well where the soil has any depth.

LUFKIN SILT LOAM.

The Lufkin silt loam consists of 6 to 10 inches of gray, or light brownish-gray friable silt loam, underlain by a light gray mottled soft silt clay or heavy silt loam. The subsoil of the slopes and slight ridges may have a yellowish cast on account of better drainage conditions. The soil in timbered areas is usually streaked with dark iron stains, and in general it does not contain much organic matter. Small iron concretions are strewn over the surface and to a less extent through the soil and subsoil. Heavy clay is encountered at a depth of 3 to 6 feet.

This type occurs mainly in the vicinity of Longview. A few small areas were mapped to the north of Trim Cane Creek in sec. 32, T. 20, R. 13 E., secs. 11 and 12, T. 19, R. 12 E., and secs. 15 and 16, T. 19, R. 13 E. The surface is level to gently rolling, the type being more level and the drainage less efficient as a whole than is the case of the Oktibbeha silt loam. The soil also differs from the Oktibbeha silt loam in being finer textured and more heavily timbered with pine and an undergrowth of small oaks.

The Lufkin silt loam is a residual type derived from a very silty material, having a depth of 3 to 6 feet over the heavy Lignitic clay. It is not certain whether this material represents a light silty phase of the Lignitic clay formation or a very silty phase of the Yellow Loam formation. There are some reasons to believe it is the latter, the material being quite loesslike in character.

Very little of the type has ever been cleared. At the time of the survey a few areas were being farmed. Cotton and corn generally give light and uncertain yields. The soil would make excellent land for cotton, corn, and forage crops if good drainage were established. If well drained it would also likely prove a good tomato soil. Liming would prove beneficial, and cowpeas and the like should be grown extensively to add humus and nitrogen to the soil.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Lufkin silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
10000.....	Soil.....	2.0	2.4	1.4	4.6	1.1	76.3	12.6
10001.....	Subsoil.....	.0	.4	.3	1.2	1.1	50.8	45.4

LUFKIN CLAY.

The Lufkin clay, as developed in the larger level and gently rolling areas, has a dark-brown soil, 3 to 5 inches deep, consisting of a heavy silt loam to a silty clay loam. This gives way directly to a light gray mottled heavy and tough plastic clay, changing to a light steel-gray at a depth of 2 to 3 feet. The mottling of the subsoil is with yellow and yellowish-brown. The soil clods where plowed and has a tendency to remain somewhat cloddy throughout the growing season.

The rolling and broken areas, generally bordering the stream bottoms on the south, have very little soil, and this is generally a dark-brown clay loam. The subsoil here is a very heavy tough clay, streaked and mottled to a considerable extent with reddish-brown and red iron stains. Where this clay is exposed in the road it has a peculiar brownish cast.

The Lufkin clay is the main flatwoods type, being more extensive than any other soil in the county. It occurs mostly in level and gently rolling areas, and to a less extent in rolling and broken strips bordering nearly all of the stream courses through the flatwoods belt on the south. The area just west of Starkville and extending about 7 miles south and as far west as Seitz's store has a very waxy, puttylike subsoil. This area may be considered as typical. The timber growth here consists largely of oak. All of the slopes bordering the bottoms, too, are heavy, but the level areas in the western half of the county for the most part have a deeper silty soil and the subsoil is not so tough. They are timbered with a mixed growth of pine and oak, which is inclined to be scrubby. Having such a heavy subsoil, practically all of the drainage is from the surface. For this reason the level areas are very poorly drained.

The Lufkin clay is derived from the Lignitic clay formation, where all of the later formations have been eroded away. The roads are almost impassable during the wet winter months, and just after rains during summer. When dry, however, they are as hard as a pavement.

Less than 10 per cent of the Lufkin clay is under cultivation, and the cultivated areas are confined largely to the slopes, where there is enough fall for the surplus waters to run off. Some of these areas produce as much as one-half bale of cotton and 15 to 25 bushels of corn per acre. Sugar cane does well. The level areas give uncertain yields. If the seasons are just right the crops are about as good as on the rolling areas, but if the seasons are at all wet the yields are inferior. They also are low during dry seasons, because the heavy clay subsoil prevents much root development below the surface few inches.

A great deal more can be done with this soil than is being done at the present time. Nearly every area has at least a slight fall in some direction. By ditching the depressions and laying off the rows so that they would drain themselves many areas not now used could be brought under cultivation and made to grow remunerative crops of cotton, corn, sugar cane, sorghum, and the grasses. Being a difficult soil to till, it will always be considered less desirable than some of the lighter-textured soils, but even this deficiency can be somewhat overcome by drainage and the incorporation of organic matter.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Lufkin clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
16902-----	Soil-----	0.0	0.6	1.1	3.8	1.8	75.2	16.7
16903-----	Subsoil-----	1.6	3.0	1.4	3.4	.5	32.1	57.5

OCKLOCKNEE LOAM.

The Ocklocknee loam varies considerably in the different areas and in different parts of the same area, on account of the modifying influences of the different upland soils. In general the soil is a brown, mellow, fine sandy loam from 12 to 24 inches deep, and the subsoil a grayish mottled clay loam or sandy clay. With the finer distinctions recognized the sandier areas would be classed as the Ocklocknee fine sandy loam. Other local spots would be classed with some of the heavier types.

Through the eastern third of the county the type has been modified more or less by the Selma chalk, which appears at the surface on many of the slopes, either as chalk or as the Houston clay. This influence is most noticeable along the smaller streams. The soil here is a brown to dark brown fine sandy loam, underlain at a depth of 12 to 24 inches by a black subsoil, varying in texture from a heavy loam to a heavy clay. In the larger bottoms the soil and subsoil answer to the general description given above.

The areas of this type along Browning Creek and its tributaries, in the southeast corner of the county, have a light-brown soil and a brownish-gray subsoil in most places. At varying depths, generally not exceeding 4 to 5 feet, a black clay is encountered. The light color of the soil is due to the large quantity of wash from the Susquehanna clay upland.

The areas in the western end of the county have not been influenced by the Selma chalk. The soil here is a brown or brownish-gray fine sandy to silty loam, underlain at a depth of 15 to 24 inches by a mottled gray clay loam or clay.

The principal areas in the western part of the county are along Golden Horn, Sand, Cypress, Big, and Trim Cane creeks and a few of their tributaries. These do not extend much farther east than the high rolling uplands. In the eastern part of the county the bottoms of Hollis, Skinner, Shaw, and Browning creeks and their tributaries are mostly of this type. Other areas are found in the upper bottoms of Sand and Catalpa creeks, also along Turkey Creek and a number of smaller streams. North of Starkville, Trim Cane Swamp is bordered by a low, irregular terrace of sandy lands. This terrace and the smaller bottoms draining the chalky areas are decidedly calcareous. The soil for the most part is a light brownish sandy loam, overlying a dark heavy subsoil. These areas were mapped as the Ocklocknee loam because their limited extent would not justify a separate classification. They grow about the same crops as the typical areas.

The larger areas are purely alluvial, while the smaller ones are partly alluvial and partly colluvial. Many of the areas mapped as this type had a much heavier soil before they were cleared. The black underlying material is this soil now buried by 2 to 6 feet of sandier material. There is so much erosion still going on along the slopes that further modifications in the type may be expected.

This type is nearly all under cultivation. It is used principally for corn and cotton, although a number of crops are grown in a limited way. It makes good oats, and produces heavy yields of sorghum, sugar cane, and Johnson grass. Alfalfa does well on the best drained areas. Cotton yields from one-half bale to 1 bale and corn from 25 to 50 bushels per acre. Seventy-five bushels of corn can be grown where the best methods of cultivation are used.

The areas influenced by the Selma chalk as a rule hold humus better than those along the western edge of the county, and the yields, too, are somewhat better, but the difference is not very marked. The variations in the type are not apparent in the crop, as similar variations would be in upland types, where the moisture conditions are not so uniform. Occasional overflows keep the soil in a moist condition.

Many of the bottoms need better drainage. Any seepage from the hills should be cut off by ditches. The damage from overflows could be greatly reduced by deepening and straightening the channels.

The following table gives the results of mechanical analyses of the soil and subsoil of the Ocklocknee loam:

Mechanical analyses of Ocklocknee loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16884.....	Soil.....	0.1	0.8	1.6	20.4	7.9	51.8	16.9
16885.....	Subsoil.....	.0	1.0	2.5	30.0	3.4	45.8	16.9

CATALPA SILT LOAM.

The Catalpa silt loam, to a depth of 8 to 20 inches, is a dark brownish or brownish-gray fine heavy loam to clay loam. The subsoil varies from a jet black tough clay in the smaller bottoms to a dark grayish mottled clay of about the same texture in the larger bottoms. The soil generally is deeper and of a darker brown color in the small areas. Local areas have been modified by chalk washed from the adjacent slopes. The soil in such areas have a chalky-gray color, the subsoil usually being the same as elsewhere. The type as a whole has a much more friable soil than the Wabash clay, although it clods considerably under cultivation.

The type is confined to the eastern third of the county. The principal areas are in the bottoms of Ash, Sand, Brier, Catalpa, and Red Bud creeks. A few narrow strips were mapped in the bottom of Trim Cane Creek, bordering the chalky bluffs.

This is largely an alluvial soil built up from local wash and modified by calcareous material from the Selma chalk formation. The smaller strips and chalky areas referred to above have been laid down since the uplands were cleared. The black subsoil is what was the soil before the country was settled. In the large swamps the recent changes in the soil have not been so great on account of their being timbered and lying farther away from the source of the wash material.

To bring much of the type under successful cultivation it was necessary to deepen and straighten the streams. This has been done in nearly all of the smaller bottoms, and at different places in the larger bottoms of Sand and Catalpa creeks. Besides the undeveloped areas which only need to be drained to become valuable land, much yet remains to be done in the line of drainage to bring the cultivated areas up to a high state of development. A number of small areas are being ruined by seepage, while many others are swamped during every heavy rain with waters from the hillside streams. These conditions can be overcome at a small cost.

The Catalpa silt loam is one of the most highly prized soils in the county for all kinds of general farm crops. Cotton yields from one-

half bale to 1 bale and corn from 30 to 60 bushels per acre. Bermuda and Johnson grasses give heavy yields of hay. Oats, sorghum, and sugar cane also do well. Alfalfa stands well and yields heavily on the better drained areas, though only a few fields have been planted to alfalfa so far. Chief attention is given to cotton and corn. The yields of these two crops could be greatly increased if the land were given more thorough preparation.

The following table gives the results of mechanical analyses of the soil and subsoil of the Catalpa silt loam:

Mechanical analyses of Catalpa silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16890.....	Soil.....	0.0	0.5	1.0	4.7	1.4	79.1	14.0
16891.....	Subsoil....	.1	.9	2.0	14.1	4.8	63.1	15.4

OCKLOCKNEE CLAY.

The soil of the Ocklocknee clay, 4 to 6 inches deep, is a dark brownish-gray to brown loamy clay or heavy clay loam, containing very little material coarser than silt. Below this is a gray or drab, plastic silt clay, mottled and streaked with rusty brown and yellowish iron stains. The mottling decreases with depth and the color becomes a lighter gray. A cultivated field, when the soil is dry, has a grayish cast. The soil does not bake or crack badly on drying, and when wet it is much less plastic and sticky than the soil of the Wabash clay.

This is almost the exclusive type of the bottom lands through the flatwoods proper, where the Lignitic clay formation comes to or within a few feet of the surface. These bottoms vary from a few rods wide, along the smaller streams, to more than a mile wide in parts of the bottoms of Sun and Trim Cane creeks. They represent alluvial deposits built up from the Lignitic clay and the overlying silty material. The smaller areas usually represent a light phase of the type. Trim Cane Swamp, after it passes into the Selma chalk belt, has been influenced to some extent by wash brought down by the small streams. The soil on the south side of the stream, in places, is a dark-brown clay almost as heavy as the Wabash clay. The agricultural differences in these slight phases being of no consequence, no effort was made to show them on the soil map.

The small bottoms and parts of the large bottoms are subject to frequent overflows, especially during the winter months. Even the higher parts of the large bottoms are occasionally flooded. The natural drainage is not good, but extensive areas have been brought under successful cultivation by cleaning out and, in places, straight-

ening the streams. Many other areas are being farmed, where no effort has been made to improve the drainage conditions. About one-fourth of the type is now under cultivation. It is most extensively developed in the bottoms of Sun, Biba Wila, Lick, and Self creeks. There are also a number of areas along Trim Cane, Talking Warrior, and Chinchahoma creeks. If Trim Cane, Biba Wila, and Sun creeks were canaled, every acre of their bottoms could be brought under cultivation. Such an undertaking would prove very profitable, and it is only a question of time before something will be done in this line. The cultivated areas are now valued at \$20 to \$30 an acre.

Corn and cotton are the principal crops. Cotton yields from one-half to 1 bale and corn from 25 to 50 bushels per acre. Sorghum and sugar cane give heavy yields. Bermuda grass and alfalfa would prove paying crops where the land is well drained.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Ocklocknee clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16888-----	Soil-----	0.0	0.6	0.8	3.5	1.7	45.9	46.9
16889-----	Subsoil----	.1	.8	1.0	2.9	1.0	42.6	51.9

WABASH CLAY.

The Wabash clay, to a depth of 9 to 12 inches, is a very dark-brown to black clay, rendered loamy by a good supply of humus. The soil is very sticky and plastic when wet, but on drying it cracks and crumbles, for which reason it is often referred to as "buckshot land." When the moisture conditions are right, it can be reduced to fairly good tilth. Being very retentive of moisture, it will tide crops over prolonged droughts without much injury, if a surface mulch be maintained. The subsoil to a depth of 3 or more feet is a black or dark brownish mottled heavy clay.

The Wabash clay is the least extensive of the bottom-land types, and does not occur west of where the Selma chalk outcrops. It occurs principally along the small streams rising in Houston clay areas and in the larger creek bottoms bordering the chalky bluffs or Houston clay areas on the south. The exception to this is found in the lower bottoms of Browning Creek, where one of the largest areas mapped is found. The bottoms of Okahatta, Ittobechi, and Josey creeks are entirely of this type, also most of that of Rocky Bottom Creek. The area lying mainly in sec. 32, T. 20, R. 15 E., and the one in sec. 1, T. 19, R. 15 E., occupy slight elevations sloping gently toward the

creeks. They are above overflow. A few small areas occur similarly farther west along Trim Cane and Sun creeks.

All of the small bottoms occupied by this type are subject to occasional overflows. Otherwise they are fairly well drained in most places. The areas in Sand and Catalpa creek bottoms need better drainage.

Nearly all of the Wabash clay is under cultivation. It is a difficult soil to handle, but it is highly prized for the growing of corn, cotton, and forage crops. Cotton does not fruit heavily, but it grows large enough to give good yields anyway. Practically all of the strip along Ittobechi Creek is used for hay and pasturage. The area in sec. 32, T. 20, R. 15 E. is devoted to grass and alfalfa, and that in sec. 34, T. 20, R. 14 E. has recently been planted almost entirely to alfalfa. The other areas are devoted mostly to cultivated crops. The tendency is to grow more alfalfa and grasses for hay. Both Bermuda and Johnson grass give heavy yields. Alfalfa is proving a very successful crop where the drainage is good. Cotton yields one-half bale to 1 bale and corn from 30 to 60 bushels per acre.

WAVERLY LOAM.

The Waverly loam, typically, consists of 7 to 10 inches of light to medium loam, gray in color, underlain by a light-gray fine sandy clay that extends to a depth of several feet. The soil shows some mottling, and in most places does not contain much humus below the immediate surface. Narrow strips along the streams have a brownish friable soil, varying from a fine sandy loam to a silt loam. The subsoil is a light-brown heavy silt loam or very fine sandy clay. In all but the better drained areas the soil has a tendency to clod.

This type is confined to the alluvial bottoms of Sand Creek and Noxubee River, along the southern border of the county. Farther east, in the large bottom of the Noxubee River, it grades into the Waverly clay. These bottoms are poorly drained, and large areas back from the streams are kept almost saturated with water, except during dry weather. Practically all of the type is subject to overflow and the lower areas are flooded not only at frequent intervals during the winter months, but also occasionally during the summer.

The timber growth consists principally of oak and sweet gum, in some of the sloughs and wet places cypress is found, and the better drained strips along the streams support a mixed growth of oak, beech, holly, sycamore, etc.

The few areas under cultivation are confined largely to the better drained lands. Crops are rendered uncertain by overflows. If the seasons are not too wet, cotton and corn give good yields.

With good drainage the Waverly loam would be classed among the best land of Oktibbeha County.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Waverly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16942-----	Soil-----	0.0	0.8	0.4	88.8	14.5	37.8	13.3
16943-----	Subsoil----	.0	.4	.3	24.5	10.4	43.2	20.9

WAVERLY CLAY.

The surface 3 to 6 inches of the Waverly clay consists of a mottled grayish or brownish-gray, slightly loamy silt clay. This gives way directly to a light-gray mottled silt clay, which is very soft when wet, but not very plastic. Where cultivated the soil bakes and clods and otherwise shows the need of better drainage. The organic content is rather low.

The Waverly clay occurs along the southern edge of the county in the Noxubee River bottom, and is also the most extensive type in the larger bottoms of Big and Cypress creeks. It represents purely alluvial material transported for some distance, in this respect differing from the Ocklocknee clay, which has been influenced locally by the Lignitic clay formation. It is lighter colored and much less plastic than the Ocklocknee clay.

The principal timber growth consists of sweet gum, oak, and scattering hickory. Cypress trees are found in some of the wetter strips, while some of the better drained areas support a mixed growth of oak, hickory, holly, and beech.

Only a small acreage is under cultivation. A few small areas are farmed without providing any artificial drainage. With good seasons cotton will yield as much as three-fourths bale, and corn from 20 to 50 bushels per acre. The crops are rather uncertain on account of wet seasons and overflows.

The Waverly clay, with the Waverly loam, offers excellent opportunity for extensive drainage work. A project to reclaim all the affected areas of these two valuable soils could be carried through with absolute certainty of profitable results.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Waverly clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16944-----	Soil-----	0.1	1.2	0.8	4.2	3.6	57.4	38.2
16945-----	Subsoil----	1.6	2.1	1.8	4.8	1.9	53.7	33.8

SUMMARY.

Oktibbeha County, comprising about 446 square miles, lies in the eastern part of Mississippi. It is crossed by three main physical divisions, differing in topography, soils, and extent of development. The eastern third, which is in the limestone belt, and the better parts of the red hill region, along the western boundary, are fairly well settled, but the intervening flatwoods section, except in a few neighborhoods, is very sparsely settled. The negroes are confined largely to the eastern part of the county, where they tenant a great deal of the lands.

Starkville, population 2,000, is the county seat and chief market. Fairly good railroad transportation facilities are had. The public roads are good the greater part of the year.

The climatic conditions in the county are very favorable to a wide variety of crops for home consumption.

Cotton is the important crop. Though corn is grown extensively, the majority of the farmers do not produce enough for their own use. The more progressive are beginning to grow hay for the market and find it very profitable. A few others have profitable dairy herds. Very little fruit or truck growing is done, although there are soils in the county admirably adapted to these lines of farming. Practically nothing has been done so far in the line of stock raising.

Peas and other leguminous crops should be grown extensively as a means of improving the soil. No commercial fertilizers are used, except on some of the sandy lands, principally through the western part of the county.

The tenant system prevails, and there is little difficulty in securing labor under this arrangement. Floating labor is, in general, scarce.

The census of 1900 reports 207,895 acres in farms, of which about one-half is improved. Thirty per cent of the farms are operated by the owners, the remainder by tenants. Land values are still comparatively low.

The county has a great diversity of soils. In all 21 types were recognized.

The Oktibbeha fine sandy loam is best adapted to cotton, corn, and forage crops, and peaches, pears, and plums do well. The soil is easy to improve.

The Oktibbeha clay, being largely an erosion type, is droughty and hard to handle. The type should be devoted to pasturage.

The Oktibbeha silt loam is one of the flatwoods types and has poor natural drainage. The few areas farmed produce light yields of cotton and corn. With good drainage established the soil would prove well adapted to a variety of crops.

The Oktibbeha clay loam, though confined to the flatwoods belt, is rolling enough to have good drainage. It is extensively farmed and especially adapted to cotton, grain, and grasses.

The Orangeburg fine sandy loam is a hilly type, and only a small portion of it is under cultivation. Cotton gives light yields, except where commercial fertilizers and coarse manures are used. Peaches would do well and probably tobacco on some of the best areas.

The Orangeburg clay is very limited in extent and so badly eroded as to be, in most cases, unfit for agriculture. A few small areas produce good crops of cotton. The badly eroded areas should be used for Bermuda grass or abandoned to forest.

The Norfolk fine sandy loam is best adapted to cotton and early truck. It is being used principally for cotton and corn. Some system of rotation should be practiced so as to keep the soil better supplied with humus.

The Myatt fine sandy loam is not farmed to any extent. Crops often suffer from the lack of drainage. With good drainage the type would grow corn, oats, and forage crops. Areas near the railroad would prove valuable for the production of strawberries.

The Myatt clay loam is very limited in extent. The few areas under cultivation, except during wet seasons, give better yields than the lighter upland soils. Corn and cotton are about the only crops grown. Oats would do fairly well. The yields would be much better if good drainage were established.

The Susquehanna silt loam produces fairly good crops of cotton, corn, and oats. Bermuda grass would afford good pasturage. A large percentage of the soil is under cultivation.

The Susquehanna clay is badly run down in most areas, and large tracts have been practically ruined by erosion. The yields of cotton and corn are light. The rough, eroded areas should be sodded to Bermuda and devoted to pasturage. Stock raising and dairying are two promising industries for the type.

The Houston clay is the most highly prized of the upland soils for all of the crops of the area. Cotton, corn, grasses, and melilotus make a luxuriant growth. Bermuda grass makes excellent pasturage. Alfalfa does exceptionally well. The Houston clay is a good soil for all kinds of farming, except truck and fruit growing.

The Houston chalk for a long time was looked upon as being practically worthless, but now it is beginning to be regarded as quite valuable for pasture lands. Where there is any soil melilotus thrives, and the better areas grow good grasses. The type should not be cultivated.

The Lufkin silt loam is level and naturally poorly drained. It would make excellent land for cotton, corn, and forage crops if good drainage were established.

The Lufkin clay is the main flatwoods type, only about 10 per cent being under cultivation. Areas rolling enough to provide good surface drainage will grow good crops of cotton, corn, sugar cane, and grasses, but the level areas give uncertain yields. It is difficult to till and in this respect less desirable than the lighter textured soils.

The Ocklocknee loam is the lightest textured of the alluvial types and nearly all of it is under cultivation. All properly cultivated crops produce heavy yields. Cotton does not do well in most areas on account of overflows. The type is best adapted to corn, oats, sorghum, sugar cane, and grasses. Alfalfa does well on the best drained areas.

The Catalpa silt loam is a grade heavier than the Ocklocknee loam, but the two types are adapted to the same line of crops and the yields are not much different. A great many of the cultivated areas need better drainage. The undeveloped areas only require drainage to become valuable land.

The Ocklocknee clay is the most extensive of the bottom-land types. The natural drainage is not good, but extensive areas have been brought under cultivation by clearing out and in places straightening the streams. Many other areas are being farmed where no effort has been made to improve the drainage conditions. The drained areas are highly prized for cotton and corn. A number of other crops would do equally as well.

The Wabash clay is not extensive and occurs only in the limestone section. It is rather a hard soil to handle, but produces good crops of corn, cotton, and grasses. The best drained areas are well adapted to alfalfa.

The Waverly loam and the Waverly clay are poorly drained types along the larger streams in the southern part of the county. Cotton and corn are grown on the small areas under cultivation, and in dry seasons the yields are usually good. The two types offer an excellent opportunity for extensive drainage work. The project to drain these swamps can be gone about with absolute certainty of profitable results.

SOIL SURVEY OF PRENTISS COUNTY, MISSISSIPPI.

By W. J. GEIB and C. W. MANN.

DESCRIPTION OF THE AREA.

Prentiss County lies in the northeastern corner of Mississippi and is bounded on the north by Alcorn County, which extends to the Tennessee State line, on the east by Tishomingo County, reaching

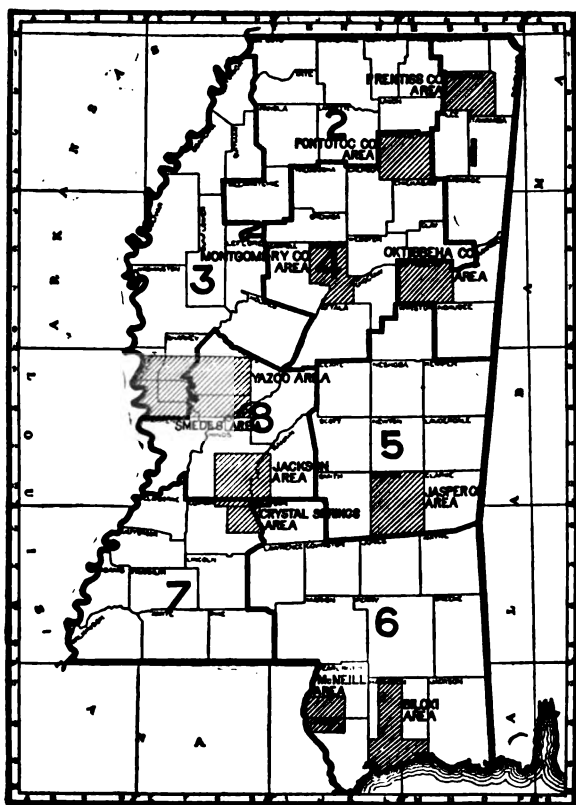


FIG. 16.—Sketch map showing location of the Prentiss County area, Mississippi.

to the Alabama State line, on the south by Itawamba and Lee counties, and on the west by Union and Tippah counties. The outlines of the county approximate a rectangle 20 miles from north to south by 23 miles from east to west. The county comprises an area of 265,792 acres, or about 415 square miles.

Early geological reports speak of this section of the State as the "Northeastern Prairie," but this term as applied to Prentiss County is very misleading, the prairie region not extending as far north as this. In topography the surface of the county varies from broken and hilly to rolling, with some gently rolling areas, and here and there a small stretch of level land. The roughest and most irregular section is found in the northeastern part of the county, where many of the slopes are too steep to be cultivated. From Tuscumbia Creek to the east county line and extending south to Mackys Creek the surface consists of a series of parallel ridges, extending from north to south or from northwest to southeast. These ridges vary in height from 20 to 50 feet. Except in the north part of this strip, the slopes can all be used for cultivated crops. The hills throughout this region are covered with a growth of shortleaf pine. Another range of hills, known as the "Tippah Hills," lies partly within the area, extending from a point 2 miles southwest of Geeville northward to where Dry Creek enters the county. Many of the slopes in this range are also too steep to be farmed. In the vicinity of Thrasher, Booneville, Wheeler, and Baldwin there are small areas which are gently rolling. The remainder of the county varies from rolling to gently rolling, with occasional terraces and broad, level bottoms along the creeks. The highest point in Prentiss County is said to be at Booneville, where an elevation of 554 feet is attained. This is also the highest point on the Mobile and Ohio Railroad between Mobile, Ala., and Cairo, Ill.

A very distinct, though somewhat irregular, drainage divide crosses the county from east to west. It enters the area $2\frac{1}{2}$ miles northwest of Blackland and extends northeast to the road which runs from Booneville to Dry Run, whence it turns southeast and continues in this direction to 1 mile southeast of Booneville. At this point it makes a sharp bend to the northeast and extends to the north county line, where it again turns southeast, leaving the county about 4 miles south of the northeast corner. The drainage of the extreme northeast corner is through Yellow Creek directly into the Tennessee River. The remainder of the county north of the divide drains its waters through Pollys, Boones, and Tuscumbia creeks into the Tuscumbia River. Dry Creek, in the extreme northwest corner, flows into Hatchie River, which joins with Tuscumbia River, emptying into the Mississippi. South of the divide the streams all flow in a southerly direction. Mackys Creek crosses the southeast corner of the area. Big Brown Creek rises $1\frac{1}{2}$ miles from the north county line, about 4 miles from the northeast corner, flows almost due south, and leaves the county about 5 miles southeast of Marietta. It receives the waters of Hurricane and Little Brown creeks and after crossing the south line unites with Mackys Creek. Twenty-mile Creek crosses the

southwest corner of the survey from $2\frac{1}{2}$ miles northwest of Geeville to Baldwyn and receives the waters of Wolf and Osborne creeks. After leaving the county Twenty-mile Creek flows into Mantachie Creek, which joins Mackys Creek to form the Tombigbee River, a stream flowing into the Gulf of Mexico through Mobile Bay. The current in none of these streams is sufficiently swift to be of use as a source of power.

Prentiss County was established from a part of Tishomingo County in 1870. The original surveys were made about 1834, and the first settlements took place between 1830 and 1840. At the time of organization the county had a population of 9,344, of which 1,754 were colored. In 1900 the population was 15,788. The early settlers came chiefly from the Carolinas, Georgia, Alabama, and Tennessee. Owing to the more favorable topography and better soil conditions, the west part of the county was settled first, and it is at present the most thickly settled section.

Booneville, with a population of 1,600, is the county seat and the chief business and distributing center between Corinth and Tupelo. It is situated near the center of the county and draws considerable trade from adjoining counties. Baldwyn, located 12 miles southwest of Booneville, on the south county line, has a population of 1,200 and is a prosperous town. Wheeler, Thrasher, Geeville, and Marietta are villages of less importance.

The Mobile and Ohio Railroad crosses the area from north to south and affords adequate transportation facilities for the business now conducted. It is a direct line from St. Louis to Mobile and New Orleans. The distance from Booneville to St. Louis is 335 miles, and from Booneville to Mobile is 308 miles.

The wagon roads throughout the county are usually in good condition during the summer and fall months, but during winter and spring it is almost impossible to travel over some of the roads traversing the clay areas. There is no road material in the area surveyed, but a very good grade in the form of chert can be obtained at Iuka, Miss., and shipped in at a moderate cost. The roads should be graded and crowned with gravel and chert.

Booneville is the chief market in the county for cotton and other farm produce. Baldwyn is a market of less importance. Some vegetables and a small quantity of fruit are shipped to points north and south, but the supply is very limited.

CLIMATE.

The climatic conditions prevailing in Prentiss County are those of a warm temperate zone. The average annual temperature is 61.6° F. The coldest months are December, January, and February.

with an average temperature of 43.6° F. Freezes and light snows occur frequently, though they are of short duration. The mean temperature during July and August is 80° F. The annual precipitation is 49.7 inches, which is fairly well distributed throughout the year, but January and February are generally considered the rainy months.

The following tables give the normal monthly and annual temperature and precipitation and the dates of the last and first killing frosts as reported by the Weather Bureau station at Booneville. The average date of the first killing frost in the fall is November 3, and of the last in the spring, April 1. This gives a growing season of two hundred and sixteen days for the tenderest vegetation. The mild climate, coupled with excellent drainage and a good supply of water, insures healthfulness. A few crops could be grown with profit during the winter months. A long grazing period for cattle is afforded, and much work in the way of clearing land, making compost manure, and plowing can be done even during the coldest months of the year.

Normal monthly and annual temperature and precipitation.

Month.	Booneville.		Month.	Booneville.	
	Temperature.	Precipitation.		Temperature.	Precipitation.
	°F.	In.		°F.	In.
January.....	41.7	4.75	August.....	79.5	2.98
February.....	43.8	5.57	September.....	78.8	2.80
March.....	51.8	6.96	October.....	68.2	2.15
April.....	60.0	4.38	November.....	52.0	4.15
May.....	70.0	2.91	December.....	45.5	4.02
June.....	77.8	4.22	Year.....	61.6	49.70
July.....	80.5	4.86			

Dates of first and last killing frosts.

Year.	Booneville.		Year.	Booneville.	
	Last in spring.	First in fall.		Last in spring.	First in fall.
1898.....	Apr. 6	Oct. 26	1908.....	Mar. 25	Oct. 25
1899.....	Apr. 9	Dec. 3	1904.....	Mar. 28	Oct. 23
1900.....	Mar. 31	Nov. 9	Average.....	Apr. 1	Nov. 3
1902.....		Oct. 29			

AGRICULTURE.

A careful study of the development of agriculture in Prentiss County reveals the fact that, while two crops, cotton and corn, have been grown almost exclusively, and while in general the old methods have been rigidly adhered to, slight changes in the crops grown and

in the methods practiced have been slowly making way, until at the present time the farmers are coming to realize the importance of diversified farming and of improved methods of culture. Prior to 1835 a few white settlers had taken up lands in the county, but not until after 1845 did active permanent settlement begin. The greater part of the county was covered with forests of shortleaf pine, oak, chestnut, and hickory. On the bottom lands were sweet gum, oak, and beech. By 1855 some large plantations were operated with slave labor, brought from eastern States. Cotton, corn, wheat, oats, rye, and barley were grown before the war. Live stock, including horses, mules, cattle, and sheep, was kept and sheep raising in particular was a profitable industry. In these early days cotton was hauled to Memphis, a week or more being required to make this trip of 100 miles.

The completion of the Mobile and Ohio Railroad in 1861 greatly facilitated the marketing of cotton and assisted in the development of this and other industries. With the exception of corn, very little grain has been produced since 1865.

According to the Twelfth Census, 29 per cent of the land in Prentiss County is improved, and in this is included the cleared land which is not under cultivation at the present time. Within the last decade considerable progress has been made in the agricultural methods practiced. In general, as stated, farm operations are directed to producing two crops—cotton and corn. The acreage of cotton probably exceeds that of corn, and with the majority of farmers cotton is the only money crop. No definite system of crop rotation is in use even among the most progressive farmers. By the liberal use of commercial fertilizers fair crops of cotton and corn are obtained on the same fields year after year. On the bottom soils fertilizer is seldom used because of the high natural productiveness of the land.

Plowing for cotton is commenced about April 1 and continues until the middle of May. After plowing to a depth of 3 to 5 inches with a small turning plow a spike-tooth harrow is used to level and reduce the surface. The land is then thrown into ridges with a double-moldboard plow, commonly called the middle breaker. The first operation of plowing may be entirely omitted, as is often the case. Fertilizer when used is dropped in the furrow made by the ridging or bedding process and is then covered by rebedding, which is done by running the middle breaker through the center of the old ridges. Before planting the ridges are smoothed with a top harrow or log. The one-horse cotton planter is used and is adjustable for different rates of seeding. From one-half bushel to 2 bushels of seed is planted to the acre; the best practice requires about one-half bushel. The crop receives from three to five cultivations, and farmers who are

most successful with the crop recommend even more frequent cultivation. The shovel plow is generally used for cultivating, though the two-horse cultivator has recently been introduced. Only the short-staple cotton is grown. A few attempts have been made to grow the long staple, but because of the smaller yields obtained it has not been found profitable, and, moreover, little distinction is made in the price in the local market. In the spring the old cotton stalks in the fields are mowed off with a revolving stalk breaker drawn by two horses and the stalks are plowed under. When the breaker is not used the stalks are sometimes burned.

Corn is planted on all the soils of the area. Plowing is usually begun from two to three weeks earlier than for cotton. A white dent strain and Tennessee Red Cob are the only varieties grown extensively. The entire crop is used for local consumption. The average yield is about 18 bushels per acre. In the fall, while still green, the leaves are gathered from the stalks and the ears are left to mature. Small bundles of the leaves are made and allowed to cure in the field, and after one or two days these are bound together into larger bundles and preserved as fodder. It is thought that the practice is somewhat injurious to the grain, especially when the leaves are stripped before the grain has fully ripened. As a rule no care is taken to select improved seed. The yields are frequently low, but if attention is directed to improving the soil by rotation of crops and to more thorough cultivation the yields may be increased considerably.

In general, plowing should be deeper than practiced at present, especially with the heavier soils. To accomplish this the land should be plowed a little deeper each year until a depth of 7 or 8 inches is reached. Organic matter may be supplied by adding stable manure or by turning under green crops. The following three-year rotation is advocated by Director W. L. Hutchinson, of the Mississippi Experiment Station: First year, cotton; second year, corn, with cowpeas planted between the rows at the last cultivation; third year, oats or wheat, and cowpeas after the grain has been removed, followed with cotton again the fourth year. Ridged cultivation is practiced to advantage only where the land is poorly drained and subject to overflow or on the steeper slopes to prevent erosion.

No wheat is grown. Oats are grown to some extent, and are either pastured or cut and cured for hay. The crop is seldom thrashed for the grain. Cowpea vines and sorghum are also grown for hay. It is not uncommon for farmers to buy baled hay in Booneville or Baldwin for winter feed.

On some of the hillsides erosion has damaged the land to a considerable extent. Erosion could be held in check by contour cultivation and terracing. The washed places could be reclaimed by filling the deepest parts with brush, covering, and sowing a fast-growing

crop. On the lime lands melilotus grows very well, while on all of the soils lespedeza will thrive. If the soil is kept mellow enough to take up a large amount of water and if a good root system is developed there will be little danger from erosion.

Enough swine and poultry are kept in the county to supply the home demand. In the aggregate a considerable amount of stock is kept, consisting of horses, mules, cattle, hogs, sheep, and goats. There are no dairy farms in the area, and the milch cows are ordinary grades. Formerly a few Devons were kept as oxen, but in late years the work animals have been drawn from the cattle of mixed blood. The butter and milk produced, though not of high quality, supply the local demand. For the greater part of the year stock does well on the natural vegetation to be had on the range, and as a rule the cattle are allowed to find their own living during the winter. The development of the cattle industry in Prentiss County requires the introduction of some thoroughbred stock to raise gradually the standard of the native cattle. Permanent improvement would also depend on the care and attention given to providing pasture and winter feed. It is believed that more extensive stock raising would be practicable and profitable. Bermuda grass, lespedeza, vetch, and other forage plants are available for pasture. There is no doubt that alfalfa can be grown on the Houston clay, and it will probably prove profitable on the Oktibbeha clay and Guin fine sandy loam.

The growing of early vegetables commercially is engaged in around Booneville. The first strawberries are on the market by the 1st of April and English peas are marketed the last of April, while tomatoes are ready for shipment early in June. This is only about three weeks later than the early vegetables shipped from the Gulf counties of this State. The St. Louis market is reached in twelve hours by express, and other markets within easy reach are Louisville, Cincinnati, and Memphis. Some shipping is also done to New Orleans.

Fruit has never been an important crop in Prentiss County. The Guin fine sandy loam is recognized as being well adapted to the production of peaches. The relatively high altitude of the region, the climatic conditions, and the presence of large bodies of soil adapted to the crop are favorable to an extension of the peach industry. Grapes have been grown to a limited extent. The Concord, Niagara, Hartford, and other varieties yield well and are profitable for shipment. Pears are also successfully grown and yield well.

Day labor of all kinds is scarce. When labor is hired by the day the average wage is 75 cents for ten hours' work. Ordinary farm labor is usually employed to work through the season or, in the local phraseology, "to make the crop." Under these conditions \$20 per month is usually paid, with board in addition. Owing to the greater

need for help at cotton-picking time the demand for labor is especially active at that season. The wage paid for picking varies from 50 cents to \$1 a hundred pounds.

According to the report of the Twelfth Census, about 57 per cent of the farms of the county are operated by tenants. It is usual to rent on shares rather than to pay a stated money rental. Two systems of share renting are practiced. If the owner of the land furnishes the necessary tools and work animals and one-half the fertilizer, he receives one-half of the crop, both cotton and corn. The more general practice, however, is to follow the "rent system," in which the tenant provides his own tools and stock and pays the landowner one-third of the corn and one-fourth of the cotton.

The average size of farms in Prentiss County is given by the Twelfth Census as 85.8 acres. The figures are somewhat misleading, as each tenancy was classed as a farm. The actual size of landholdings varies from 40 to 1,000 acres or more, with a probable average of 160 acres. Some large tracts of land are held as timber reserves.

The value of farm lands has increased rapidly during the last few years. At present uncleared land, which is desirable for farming purposes, is valued at \$5 to \$30 an acre. Some of the roughest land can be bought for \$2 an acre. The highest priced lands are found along the streams in the western and southern parts of the county. Large areas of this land are still uncleared, but have a high prospective value. The bottom lands are valued at \$15 to \$75 an acre. The value of land in some parts of the area is influenced by the fact that artesian water can be obtained. It is reached at about 300 feet in the vicinity of Wheeler and somewhat deeper farther south. The surface wells furnish a permanent supply of fairly good water.

During the last six years the farmers of this county have experienced a period of unusual prosperity. Improved conditions are evidenced by the number of substantial houses which are gradually taking the place of the former log houses. The farm buildings in general, however, are inexpensive. Improved farm implements are steadily coming into more general use. A stock law is in force over a part of the county, so that many of the farms are fenced. The fences are constructed of barbed wire or of rails.

From \$30,000 to \$40,000 is expended annually for commercial fertilizers. The growing of clover, cowpeas, and alfalfa, as well as other forage crops, to improve the soil and to provide additional feed for stock is strongly recommended. Among the chief sources of improvement in the agriculture of the area would be the practice of deeper plowing and, in general, level cultivation for cotton and corn, the growing of more forage crops, and the gradual improvement of the live stock. The opportunity for the development of a valuable peach and grape growing industry seems to exist, and truck

farming may also be encouraged, as this will undoubtedly be very successful and add materially to the income of the county.

SOILS.

Within the area surveyed there are several geological formations from each of which soils having distinct characteristics have been derived. The area lies just within the northern limits of the Gulf Coastal Plain, which is an extension of the Atlantic Coastal Plain. The surface of this entire region was at one time completely covered with sedimentary material of the Lafayette formation, which consists of beds of sand, gravel, and clay. Throughout the eastern and northern parts of the county this mantle reaches to considerable depth and the erosion, although extensive in some places, has not cut through to the underlying formation. In the western part of the county, however, where this mantle was thin, it has been entirely eroded away in places, leaving exposed the underlying material. Early geological reports speak of this region as lying within the "Northeastern Prairie," and refer to the formation as Selma chalk. While the entire region is doubtless underlain by the Selma chalk, it outcrops only in a few places, the entire area exposed being 14 square miles.

The Lafayette formation gives rise to three soil series which, although closely related, have peculiar characteristics distinguishing them. The Guin and Oktibbeha series, which cover by far the greater proportion of the present survey, have distinctly brownish-red subsoils and are represented by the Guin fine sandy loam and the Oktibbeha clay. The Norfolk series, characterized by a yellow subsoil, is represented by the Norfolk loam. These three series are found closely associated throughout the Atlantic and Gulf coastal plains.

The formation underlying the Lafayette is the Selma chalk and consists of beds of marl, rotten limestone, and chalky material. This material is of Cretaceous age and was laid down as a marine deposit at an earlier time than the Lafayette. It is filled with numerous shells of various sizes and shapes. This formation, which is exposed only in the western part of the county, gives rise to the Houston series of soils and is represented by the Houston clay. The soils of this series have a characteristic black color and occupy the "black prairies" of Alabama, Mississippi, and Texas.

Another group of soils found within the area consists of material which has been derived from various geological formations reworked and redeposited as bottom lands along the streams. They have been included in the Ocklocknee series. This series consists of yellow-brown to gray surface soils with brownish-gray or yellowish subsoils.

Along the smaller streams the soil is lighter both in texture and color and has been classed as the Ocklocknee loam. In the western half of the county the soil has been influenced more or less by the Selma chalk formation. Where there has been much wash from the chalk the soil has turned darker and the amount of humus has increased, giving to local areas some of the characteristics of the Wabash series. The bottom soils in this part of the county have been mapped as the Ocklocknee clay loam.

The following table gives the names and areas of the several soil types shown in the accompanying map:

Areas of different soils.

Soil.	Acres.	Percent.	Soil.	Acres.	Percent.
Guin fine sandy loam.....	176,192	66.3	Ocklocknee clay loam	13,682	5.1
Ocklocknee loam.....	88,144	14.4	Houston clay.....	5,632	2.1
Oktibbeha clay	17,844	6.5	Total	265,792	.....
Norfolk loam	14,848	5.6			

GUIN FINE SANDY LOAM.

The surface soil of the Guin fine sandy loam, locally called "gray land," consists of a gray or light-brown fine to very fine sandy loam containing a high percentage of silt and extending to an average depth of 10 inches, though it may vary in different localities from 6 to 14 inches in depth. The subsoil consists of a brownish-red clay loam which contains a varying quantity of fine sand. In local areas the color may range from a yellowish red to a deep red. The predominating color, however, is a brownish red. The subsoil of this type has a smaller quantity of sand present than is usually found in the Guin soils. The areas containing the largest percentage of sand in the subsoil are confined to the rough, hilly sections, while the rolling areas have a comparatively stiff subsoil. Iron concretions are sometimes found upon the surface over the roughest parts of this soil, though their occurrence is limited. While variations occur over areas of limited extent, the soil as a whole may be considered very uniform. Owing to the sandy nature of the soil and the heavy character of the subsoil, the type is easy to cultivate and at the same time retentive of moisture.

The Guin fine sandy loam is by far the most extensive soil, occupying about 66 per cent of the county. With the exception of the bottom lands along the streams and a few terraces of Norfolk loam, it occupies practically all of the survey east of the Mobile and Ohio Railroad. There is also a large area in the northwest corner of the county and a narrow strip extending along the west end.

The surface varies from rolling to broken and hilly. There are a few areas that are nearly level or gently rolling, but these are of limited

extent. The roughest part is found in the northeast corner of the county, where many of the slopes are too steep to be cultivated. Going south from this region, the surface is not so broken, but still consists of series of low hills and ridges upon which some of the slopes would be difficult to till. Proceeding westward, the surface is only rolling, with frequent gently rolling areas, and practically all of the slopes can be cultivated. Throughout the roughest sections there are small areas of nearly level land which are very productive. The narrow strip of this soil that extends along the west border of the county is also very rough and broken. This is a part of a range known as the Tippah Hills, which form a part of the Pontotoc Ridge.

On account of the sandy nature of the soil and the uneven topography the natural drainage is excellent. The steep slopes, and often the more gentle slopes, are subject to erosion, and in some places the land has been greatly damaged from this cause.

The Guin fine sandy loam is derived from the materials of the Lafayette formation, which covers the greater part of the county. Throughout the eastern half this extends to considerable depths, but in the western part the covering is thin, the underlying material outcropping along many of the streams and on hillsides. The proximity of the underlying beds of marl and Selma chalk to the surface has influenced the Lafayette material so that the soil as found here is somewhat different from similar soils in other areas.

The original timber growth consisted of oak and shortleaf pine. The hills and ridges throughout the eastern part of the survey are still covered with this timber, though the stand is thin. Where pine has been removed and the land left idle a growth of post and black-jack oak has come up. When old fields are abandoned a thick growth of pines soon appears. The growth is rapid, and some of the timber is now being cut for lumber.

Cotton and corn are the chief crops grown, and the yields vary considerably, depending upon the topography and the methods of culture. Throughout the eastern part of the county, in the rough, hilly sections the yields are low, corn ranging from 8 to 16 bushels and cotton from one-fifth to one-half bale per acre. In the western part, under more favorable conditions, corn yields from 15 to 25 bushels and cotton from one-third to three-fourths bale per acre. For the whole type corn will average about 15 bushels and cotton one-third bale per acre. Oats are grown to a small extent; but as they are not thrashed, no yields can be given.

While cotton and corn are the chief products, this soil is adapted to a wider range of crops. The only hay produced is from the wild grasses. Lespedeza or oats and peas will make good hay and should be grown extensively. One thrifty patch of alfalfa was seen, and it is probable that this legume under judicious management could be

profitably grown on this kind of soil. It would be necessary first to bring the soil to a higher state of cultivation. Oats should be grown more as a feed for stock, and a systematic crop rotation should be followed. Garden peas, tomatoes, and strawberries do very well, and on the gently rolling areas the trucking industry could be developed. Strawberries often ripen as early as the last week in March. Peaches and grapes are grown on a small scale and seem to do very well. On the higher elevations in the vicinity of Booneville and in the extreme western section of the county the conditions seem to be the most favorable for the growing of peaches, grapes, and other fruits, for in these sections the danger of erratic frosts is less than elsewhere. One small orchard at Booneville produced nine crops in eleven years. Where the conditions are the most favorable the industry could be profitably extended.

A very small quantity of tobacco is grown upon this soil for home use. In some other sections of the South this same soil produces a fine quality of wrapper leaf tobacco, and it is probable that this industry could be built up within Prentiss County. Before undertaking it on a commercial scale, however, some experiments should be conducted to be sure that the climatic conditions are favorable and that the tobacco would be of good quality.

Commercial fertilizers are used extensively on this soil, though not judiciously. The fertilizers now in use contain enough phosphoric acid and potash, but the quantity of nitrogen is not sufficient to supply the needs of the plants. Fertilizers containing a higher percentage of nitrogen should be used and green manuring should also be practiced, as much organic matter can in this way be added to the soil and its nitrogen content and physical condition greatly improved.

The methods of cultivation should also be improved. Contour cultivation and terracing should be practiced to a greater extent, to keep the land from washing in the hilly sections. Level cultivation should be followed, for by this method more moisture can be conserved than where the fields are ridged.

Land of this type ranges in value from \$2 to \$20 an acre, depending on topography and location.

Below are given the average results of mechanical analyses of typical samples of this soil:

Mechanical analyses of Guin fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
16864, 16872.....	Soil	0.2	2.0	3.0	23.1	4.9	58.7	7.6
16865, 16871, 16873.	Subsoil	.1	1.2	2.0	24.4	3.7	49.5	18.8

OKTIBBEHA CLAY.

The surface soil of the Oktibbeha clay consists of a heavy brown loam or silty loam extending to a depth of 4 to 8 inches. A covering of 1 to 3 inches of fine sandy loam is frequently encountered. The subsoil is composed usually of red or reddish-brown heavy silty clay, which frequently contains varying quantities of fine and very fine sand, and at a depth of 24 to 36 inches along the borders of the Houston clay a gray waxy clay is sometimes found. There is a smaller percentage of sand in the subsoil of this type than is usually found in the Oktibbeha subsoils. The heaviest phases are more difficult to cultivate than the other types in the county, but under careful management little trouble is experienced in preparing the fields for a crop.

The most extensive area of the Oktibbeha clay is found immediately south of Geeville, extending to the south county line. Another broken area is found about Blackland, reaching to the northeast. Other smaller detached patches occur throughout the western part of the county. The surface varies from gently rolling to rolling, and the natural drainage is good. The soil is very compact and retentive of moisture, so that in small, level or depressed areas tile drains would be beneficial. The Oktibbeha clay is derived from materials of the Lafayette formation. Throughout the west half of the county the formation is thin and often entirely lacking. Here the Oktibbeha clay has become mixed with the underlying material to a considerable extent, which is the cause of its departure from type. The subsoil is stiffer and lighter in color than it should be.

Corn and cotton are grown exclusively. Corn yields from 10 to 25 bushels and cotton from one-third to three-fourths bale per acre. A greater variety of crops should be grown upon this soil and a systematic crop rotation, including, among other crops, oats, clover, and alfalfa, should be followed. Commercial fertilizers are in common use, but little attention is paid to their peculiar fitness for the crops or condition of the soil. Fertilizers of high nitrogen content would doubtless give better results. Green manuring crops should be introduced to supply organic matter and to improve the physical condition of the soil. Cowpeas are excellent for this purpose. Vetch and velvet beans are also good restorative crops. Deeper plowing and level and more thorough cultivation should be practiced. This will improve the physical condition of the soil and insure larger yields.

The original timber growth consists chiefly of oak and hickory, with now and then a little pine. Farms on this soil range in value from \$15 to \$25 an acre.

The table following gives the results of mechanical analyses of samples of the soil and subsoil of this type.

Mechanical analyses of Oktibbeha clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16866.....	Soil	0.1	1.9	1.2	7.9	10.2	55.1	23.8
16867.....	Subsoil.....	.0	.6	.5	1.4	10.0	50.7	36.5

OCKLOCKNEE CLAY LOAM.

The surface soil of the Ocklocknee clay loam consists of a brown or dark-brown clay loam or silt loam extending to an average depth of 10 inches, though the depth varies from 8 to 18 inches. There is present in the surface soil a considerable percentage of organic matter, which accounts, in part at least, for the dark color and the loamy characteristics. Where the type borders the Guin fine sandy loam, as is frequently the case, the two soils are more or less intermingled, and the surface of the Ocklocknee clay loam contains a larger proportion of fine sand. Such areas, however, are not of sufficient size to be indicated on the soil map. The subsoil consists of a brownish, drab, or gray clay loam or silty clay loam, extending to a depth of 36 inches or more. Beds of sand may be encountered at 3 feet, but this is infrequent. This soil is more difficult to handle than the sandy types of the area, and trouble is often experienced in securing a good seed bed. To get the best results, after the field has been plowed it should be allowed to remain so for a short time before harrowing begins; the clods seem to pulverize better than immediately after plowing.

The Ocklocknee clay loam is confined to the west half of the county south of the divide and occurs as first bottom land along practically all of the streams in this region. The most extensive development is along Twenty-mile Creek, from a short distance above Wheeler south to the county line. The width here varies from one-half mile to 1 mile. The "heavy bottom," as it is commonly called, also extends along Wolf, Little Wolf, and Osborne creeks.

The surface is level or gently undulating, and on account of the heavy nature of the soil the natural drainage is poor. Some portions of the bottoms are flooded each year, and the crops are sometimes damaged, but near the headwaters of the creeks and along the smaller branches there is little danger from floods. About half of the type is cleared and under cultivation. Through these cleared areas large open ditches have been constructed to assist in carrying off the surface water. More of the land is being cleared each year, and by the time it is all under cultivation and large ditches established there will be much less damage from floods, as the water can then be carried off rapidly. The creeks and ditches should be kept free from debris during the entire year.

The Ocklocknee clay loam is an alluvial soil, having been carried down and deposited by the streams. The material of which it is composed comes largely from the beds of marl, rotten limestone, and chalky material which underlie the entire county and which are exposed in the western part. A portion of the material also comes from the Lafayette formation.

As on the other soils of the area, cotton and corn are the chief crops. Cotton yields from one-third bale to 1 bale and corn from 20 to 50 bushels per acre. This is without doubt the best corn soil in the area, and with improved methods much larger yields could be secured. While cotton yields fairly well, the soil is not so well adapted to this staple as to corn. It does not mature as early as on the higher land, and it is apt to grow very large stalks and to fruit sparingly. Red clover produces a rank growth, but may lodge badly before it can be cut. Alfalfa is being tried on a small scale where there is no danger of overflow, but it is not likely that this venture will meet with great success, as the water table is too close to the surface. In unusually dry seasons a fair crop might be secured. Alfalfa is better adapted to higher land.

The methods of cultivation followed fall short of meeting the needs of the soil. The "middle breaker," which is now commonly used for "bedding," leaves a series of ridges from 10 to 12 inches high. A light harrow is used to pulverize the soil after the middle breaker, and when the field is ready to plant the ridges are still very prominent. The seed is planted on the top of the ridges. It is believed that level cultivation and a more thorough preparation of the soil would increase the yields and also improve the physical condition of the soil. Commercial fertilizers are not used on this type and are not considered necessary, since the soil in itself is very rich. A greater variety of crops should be grown and a systematic rotation followed. Hay would be a profitable crop. Timothy sown with clover would doubtless make a good stand. Tile drains could be installed in many places, and there is no doubt that these would greatly increase the value of the land.

The value of this soil is constantly increasing. The best farms made up of bottom land entirely are worth from \$40 to \$75 an acre. Where the land is timbered it can be bought for \$15 to \$30 an acre, depending on the character of the timber.

The table below gives the results of mechanical analyses of this soil:

Mechanical analyses of Ocklocknee clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16876.....	Soil	0.2	1.3	0.9	4.3	1.9	68.2	22.8
16877.....	Subsoil.....	.1	1.6	.9	5.6	8.2	53.3	30.0

OCKLOCKNEE LOAM.

The surface soil of the Ocklocknee loam consists of a light-brown or grayish fine sandy loam or loam extending to a depth of 8 to 16 inches. In local areas there is sufficient silt present to impart the characteristics of a silt loam. The subsoil consists of a yellowish or drab heavy loam or silty loam to a depth of 36 inches. Sometimes lenses of sand are found, and a bed of sand may be encountered at 24 to 36 inches below the surface. These variations, however, are of too limited extent to be mapped separately. This soil is easy to cultivate and a fine mellow seed bed can be secured with comparatively little labor.

The Ocklocknee loam is confined to the bottoms along the streams of the eastern and northern parts of the county. The bottoms vary in width from one-eighth mile to 1 mile. Along the south county line, where Big Brown and Mackys creeks cross into the adjoining county, the bottom has a width of $4\frac{1}{2}$ miles. Broad bottoms occur along Big Brown, Mackys, Little Brown, Tuscumbia, and Pollys creeks.

The surface is level or slightly undulating. The bottoms are subject to overflow, and crops are frequently damaged from this source. There is a smaller percentage of this soil cleared than of any other in the area, and some of the timber remaining is of considerable value. The chief growth is white oak, beech, and gum. The construction of large open ditches through the cleared portions greatly assists in carrying off the surface water. As more of the land is cleared and more open ditches constructed, there will be less danger from the floods. The danger could be greatly reduced by keeping the creeks and ditches free from débris. It is not uncommon to see fallen trees lying in the streams. About these driftwood will accumulate and retard the flow, this being sufficient sometimes to change the course of the stream.

The Ocklocknee loam is an alluvial soil, derived from material washed from the Lafayette formation, which, being of a sandy nature, has given the light texture of this soil. It is commonly spoken of as "sandy bottoms" to distinguish it from the heavy bottoms in the western part of the county.

On this soil corn yields from 15 to 35 bushels and cotton from one-third to three-fourths bale per acre. No attention is given to seeding grasses for hay, but the wild grasses are sometimes cut. Grasses should be grown upon this soil on a commercial scale, for the price of hay in this region is high, and the industry would be profitable. Commercial fertilizers are not commonly used, but where they have been tried good results have been obtained.

Bottom lands composed of this type of soil range in value from \$5 to \$20 an acre.

The table below gives the average results of mechanical analyses of samples of this soil:

Mechanical analyses of Ocklocknee loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16880, 16882	Soil	0.2	2.1	2.6	14.3	7.4	64.6	8.3
16881, 16883	Subsoil	.2	.7	3.3	28.4	9.3	44.6	13.2

HOUSTON CLAY.

The surface soil of the Houston clay, where typically developed, consists of a dark-brown or black heavy loam or clay extending to a depth of 4 to 8 inches. The subsoil is a drab, gray, or whitish waxy clay, which grades at from 24 to 36 inches into beds of marl or chalky material. Large numbers of shells of various sizes and shapes are scattered through the subsoil. If cultivated under the proper moisture conditions little difficulty is experienced in preparing a seed bed, but when wet the soil becomes very sticky and troublesome to handle. In winter the roads through this type are very bad; the mud adheres to the wheels of vehicles, making progress very difficult. This region is commonly spoken of as "black land." Over a large part of it the surface soil has been eroded, leaving exposed the whitish subsoil.

The Houston clay is confined entirely to the west half of the county. The largest area begins immediately west of Booneville and extends from 5 to 6 miles in a northwest direction. Other areas of smaller extent are found throughout the western part of the survey. The surface is rolling and the natural drainage is good. The soil is very compact and very retentive of moisture, so that crops seldom suffer from drought. The Houston clay is derived from the Selma chalk, which is of Cretaceous age. The original growth consisted chiefly of red oak, white oak, and hickory.

Cotton and corn are the only crops grown, although the type is adapted to small grains, clover, and alfalfa. Only a small part of the soil is under cultivation. Some fields have been abandoned on account of erosion. Corn yields an average of 22 bushels and cotton one-half bale per acre. By careful management these yields should be greatly increased.

The possibilities of this type are not realized at the present time and therefore no effort is being made to improve the soil or reclaim the eroded places. These "galls" can be reclaimed and made productive fields. If the eroded places are deep, brush should be thrown in and covered to level the surface. Melilotus will grow readily on these "gall spots" without attention. It should be seeded, how-

ever, so as to be sure the entire surface is covered. Lespedeza will also grow readily and may be used in the process of reclamation. Either of these can be cut for hay or plowed under, when the surface should again be seeded. This will add organic matter to the soil and improve its physical condition so that in a few years other crops may be planted.

As the Houston clay is one of the strongest alfalfa soils in the South, the type found within this area should be devoted to the production of this lucrative crop. It should be seeded in the spring upon a well-prepared, fertile field, without a nurse crop. At least four cuttings can be secured in this latitude, and a yield of 4 tons per acre obtained. Hay is now selling for \$20 a ton, which would make the gross receipts from 1 acre \$80. Alfalfa can be produced with much less labor than cotton; hence it will be seen that it is far more profitable. Clover could also be grown to advantage upon this soil. Farms composed of the Houston clay range in value from \$5 to \$25 an acre. If alfalfa is once established this soil will be worth easily \$100 an acre.

The table below gives the results of mechanical analyses of typical samples of this soil:

Mechanical analyses of Houston clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16856	Soil	0.3	1.0	0.5	14.6	12.9	46.1	23.9
16857	Subsoil.....	.7	1.8	.7	15.5	17.9	38.5	24.9

NORFOLK LOAM.

The surface soil of the Norfolk loam consists of a brown or light-brown silty loam containing a high percentage of fine sand. Frequently the fine sand predominates, when the soil has the characteristics of a fine sandy loam. The average depth is 12 inches, though it may vary from 8 to 14 inches. The subsoil to a depth of 36 inches consists of a heavy yellow loam which frequently contains a quantity of fine sand sufficient to give a marked textural peculiarity. In a few low and depressed areas the subsoil is drab or mottled in color, due to the poor drainage condition. There are a few local areas in which the subsoil is reddish-yellow, especially where the type borders the Guin fine sandy loam or the Oktibeha clay. On account of the relatively large proportion of fine sand in the soil this type is easy to cultivate, while the comparative heavy nature of the subsoil makes it retentive of moisture.

The Norfolk loam occurs only as a terrace soil and is commonly spoken of as "second bottom" or "bench land." It is found along

nearly all of the streams bordering the bottom soils, though the areas are not continuous throughout the course of the streams. An area about 6 miles long by one-half mile wide occurs along the north side of Pollys Creek. Another area lies in the immediate vicinity of Thrasher and extends along Tuscumbia Creek for a considerable distance. More of the same soil is found along Big Brown, Hurricane, and Mackys creeks and also in the vicinity of Baldwin and Wheeler.

The surface is level or gently rolling and there is frequently a gentle slope toward the stream. The natural drainage is good except in a few depressed areas where tile drains would be beneficial. The soil is derived from the Lafayette formation, portions of which have at some time doubtless been reworked and redeposited by the streams.

Cotton and corn are grown almost exclusively, although the soil is adapted to a much greater variety of crops. It is a fairly good general farming soil. Cotton yields from one-third to three-fourths bale, the average being one-half bale per acre. Corn yields from 20 to 35 bushels per acre. Oats are sometimes grown but never thrashed, so no yields can be given. Tomatoes, peas, and berries do very well. It is a good trucking soil, though not as early as soils of lighter texture. No cultivated grasses are grown at present, but they should be introduced. Red clover could be grown successfully, and on the best drained and richest places it is probable that alfalfa would also be profitable.

The greater part of this type is cleared, and there is a greater percentage of this soil under cultivation than of any other in the country. Commercial fertilizers are used. Green manuring should be practiced, and cowpeas are excellent for this purpose. Level instead of ridged cultivation should be followed, and a systematic crop rotation would be found profitable. As compared with the Guin fine sandy loam the Norfolk loam is the more desirable soil, since, with its more even topography, freedom from erosion, and its water-holding capacity, it can be more readily improved.

Farms containing this character of soil range in value from \$15 to \$30 an acre.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of this type.

Mechanical analyses of Norfolk loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16862.....	Soil	0.2	2.0	5.4	26.4	7.9	49.5	7.8
16863.....	Subsoil.....	.1	1.4	3.0	17.8	5.2	52.4	19.7

SUMMARY.

Prentiss County lies in the northeastern part of Mississippi. The surface varies from rough and hilly in the eastern part to rolling in the western part, with here and there gently rolling areas and broad level bottoms along the creeks. Booneville, the county seat, is about 90 miles southeast of Memphis, 335 miles south of St. Louis, and 308 miles north of Mobile.

Prentiss County was organized in 1870 but settlement took place between 1830 and 1840. Cotton and corn have always been the chief crops, though before the war wheat, barley, and rye were grown to some extent. Oats are grown for pasture or hay, but are seldom thrashed. The wild grasses, peavines, and sorghum are also used for hay. No definite crop rotation is followed. The "dixie" plow is still largely used, though improved farm machinery is being steadily introduced. Old methods of cultivation which heretofore have been rigidly adhered to are slowly giving way to improved methods. The large turning plow and the middle-breaker are frequently seen. Commercial fertilizers are extensively used. Considerable live stock is kept but it is of inferior grade.

A few peaches and grapes are raised and truck farming is engaged in to some extent. Both these industries give promise of profitable development.

The value of farm lands is rapidly increasing, though much of the land is still comparatively cheap, considering its agricultural value. It ranges in price from \$5 to \$75 an acre depending on location, topography, and the character of the soil.

There are five series of soils represented in the present survey, but as these are more or less intermingled the soils are not as typical as in some other localities. The Lafayette formation is by far the most extensive, giving rise to the Guin, Oktibbeha, and Norfolk series. The Selma chalk, which underlies the entire area and which is exposed in the western part, gives rise to the Houston soils. The Ocklocknee series represents two distinct classes of bottom land, both of which are developed in this area.

The Guin fine sandy loam is the most extensive soil type, occupying 66.3 per cent of the entire area. Its surface varies from rough and broken in the east to rolling farther west, with here and there gently rolling areas. Only a comparatively small percentage of the type is under cultivation. Cotton and corn are the chief crops grown at present, though it is also adapted to oats, cowpeas, clover, and probably alfalfa. It is a good trucking soil and peaches and grapes also do very well. Level cultivation, green manuring, and more thorough tillage are recommended for its improvement.

The Oktibbeha clay is a heavier soil than the same soil in other areas. It is difficult to cultivate and the yields obtained are not what they should be for this type. The judicious use of commercial fertilizers should be supplemented by green manuring. In addition to cotton and corn the soil is adapted to oats, clover, and cowpeas, and it is probable that alfalfa could be grown.

The Ocklocknee clay loam occupies the broad bottoms along the creeks in the western part of the area and is the strongest and richest soil in Prentiss County. It is dark in color and rich in organic matter. Though rather difficult to cultivate, it gives excellent results. It is a fine corn soil and produces good cotton, though it is not as early as the higher land.

The Ocklocknee loam occupies the bottoms along the streams in the eastern and northern parts of the area. It is lighter in color and less productive than the Ocklocknee clay loam. The greater part of the soil is timbered. Where cleared and ditched good crops of corn and cotton are obtained. More hay should be grown upon this soil. It is subject to overflow.

The Houston clay has been so badly eroded that there is little of the surface soil left. An effort should be made to reclaim this soil by growing melilotus or lespedeza, for when the soil is intact it is very well adapted to alfalfa. As soon as reclaimed it should be seeded to alfalfa. Red clover will also do very well.

The Norfolk loam occupies the terraces which lie adjacent to the bottoms and is commonly spoken of as "second bottom" or "bench land." It is a good general farming soil and also fairly well adapted to truck crops. Cotton and corn are the chief crops at present. Oats, cowpeas, and clover should also be grown. The surface is gently rolling or level. The soil is easy to cultivate and capable of being highly developed.

SOIL SURVEY OF JASPER COUNTY, MISSISSIPPI.

By E. L. WORTHEN and H. JENNINGS.

DESCRIPTION OF AREA.

Jasper County, Mississippi, is located a little south and east of the center of the State, the south boundary line being approximately 100 miles north of the Gulf of Mexico. The county is bounded on the north by Newton County, on the east by Clarke County, on the south by Jones and Wayne counties, and on the west by Smith County. It is 24 miles wide from east to west and varies from 27 to 29 miles in length from north to south. It includes sixteen full townships north of the Choctaw base line and five fractional townships south, making a total area of 431,872 acres or about 675 square miles.

The surface of the county is generally broken and in places too rough for cultivation.

The northern part is more level than the southern, and there occur numerous nearly flat "prairies" in this section, some of which are 2 or 3 miles in width. The southeast part of the county is especially rough and hilly.

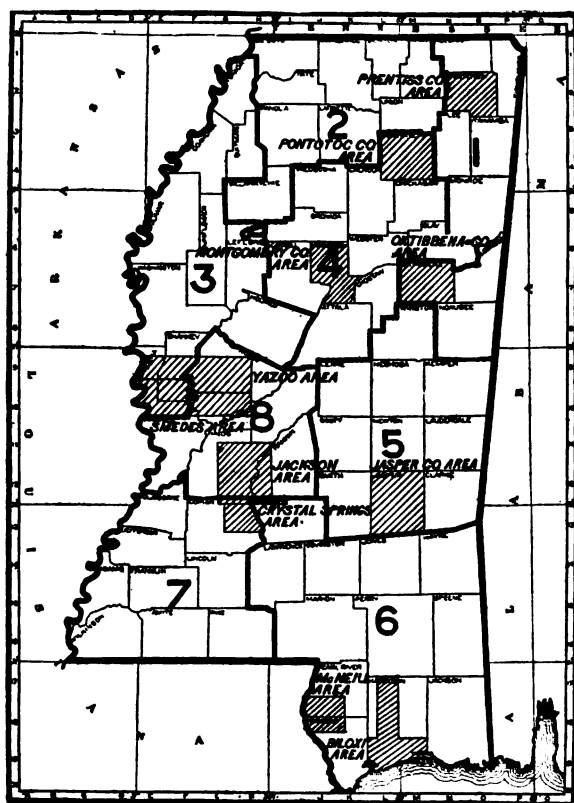


FIG. 17.—Sketch map showing location of the Jasper County area, Mississippi.

Originally all the county was timbered, with the exception of a few open prairies near the north line. The larger part is still heavily forested, only the less broken land and the top of the ridges being farmed at present. The sandy land is timbered with pine and scrub oak, the flat "prairie" with black jack and post oak, with some scattering pine, while the bottom lands support a growth of hickory, water oak, gum, magnolia, beech, and some white oak. Lumbering is extensively carried on at the present time, especially in the western half of the area. The longleaf pine forests are rapidly being removed. The turpentine and lumber industries are receiving more attention in many sections than is farming, and the value of the land depends more upon the quantity of marketable timber found upon it than upon the character of the soil.

Tallahoma, East and West Tallahala, Bogue Homo, Etehomom, and Souinlovee creeks form the principal drainage systems of the county. The whole area drains south, the five creeks first mentioned flowing south into Leaf River and the last mentioned southeast into Chunkey Creek. The bottom lands of these creeks vary from one-half mile to 1 mile in width and are heavily timbered and subject to frequent inundations. The divide in the southeastern part of the county between Souinlovee and Tallahala is high and frequently very rough.

Jasper County was established December 3, 1833, and named after Sergeant William Jasper, a Revolutionary soldier. Soon after the establishment of the county white settlers began to move in rapidly, coming generally from the States farther east, including Alabama, North Carolina, South Carolina, and Georgia. These settlers brought their slaves with them, and at the present time the population is composed of about equal numbers of whites and negroes.

The towns of Jasper County are all of small size. Paulding and Bay Spring are the county seats. The former is situated in the east-central part of the county, and the latter near the western line. Paulding, Garlandville, Claiborne, Lake Como, and Montrose are the oldest towns. Since the completion of the railroads new towns have built up and are now of leading importance. Bay Spring is the largest town in the county, having a population of about 600. It is followed closely by Montrose and Heidelberg, each having about 400 population. Vosburg, Louin, and Stringer are all thriving little railroad towns.

There are two railroads in the county, the New Orleans and North-eastern and the Mobile, Jackson and Kansas City. Both of these roads run north and south. The latter, though completed but a few years, has already been a great factor in the development of the agriculture of the western part of the county.

Practically all the farm produce is sold on the local markets. In fact, most everything produced on the farm, with the exception of cotton, is consumed in the county, though some live stock is marketed

in New Orleans, Mobile, and St. Louis. The freight service offered by the New Orleans and Northeastern Railroad makes the development of the trucking industry a possibility in the southeastern section of the county. This road, however, influences only a very small section of the county. With the further extension of the Mobile, Jackson and Kansas City Railroad, the western part of the county will be in touch with the markets of the north and northwest.

CLIMATE.

The climate of Jasper County is that of the warm temperate zone of the United States. The summers are long and the winters short and mild. The temperature seldom rises above 100° F., and —10° F. is the absolute minimum, though such cold is extremely rare, and it is very seldom that the temperature gets as low as 15° F. above zero.

There is a rainfall of about 50 inches, which is well distributed throughout the year. The greatest precipitation generally occurs in the spring and early summer. The fall months are usually dry and favorable for harvesting cotton. Even with the large annual rainfall periods of drought of such duration as to injure crops may occur in July and August, especially on very sandy types of soil where prevailing methods of cultivation are not designed to conserve moisture. By careful tillage even in these sandy soils the crops would seldom if ever suffer.

Little snow falls in this section of the State, there being many winters with none at all. The ground never freezes below a few inches, and winter legumes and cover crops such as rye and oats would grow more or less throughout the winter.

The following tables were compiled from the records of the Weather Bureau stations at Meridian, Waynesboro, and Lake Como:

Normal monthly and annual temperature and precipitation.

Month.	Meridian.		Waynesboro.		Lake Como.*	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	In.	°F.	In.	°F.	In.
January.....	47.0	5.15	47.0	4.42	45.0	3.22
February.....	53.6	5.81	50.7	4.95	54.0	4.13
March.....	54.5	5.55	56.6	4.50	62.6	3.28
April.....	65.6	4.37	64.7	4.04	61.6	3.05
May.....	70.4	4.79	72.2	3.53	68.6	5.53
June.....	77.6	6.24	78.6	5.67	78.4	4.17
July.....	78.6	5.43	81.2	5.47	78.5	6.65
August.....	79.0	4.46	80.3	5.47	79.8	6.16
September.....	73.0	2.83	75.5	3.12	79.2	1.90
October.....	62.2	1.65	64.6	1.87	67.5	.08
November.....	53.4	3.09	54.9	2.80	51.6	2.81
December.....	50.5	5.29	49.1	4.01	49.0	4.45
Year.....	63.8	54.66	64.6	49.85	64.6	43.41

* The temperature and precipitation for Lake Como are for the year 1904, without departures from the normal.

Dates of first and last killing frosts.

Year.	Meridian.		Waynesboro.		Lake Como.	
	Last in spring.	First in fall.	Last in spring.	First in fall.	Last in spring.	First in fall.
1898.....	Apr. 8	Oct. 27	Apr. 8	Oct. 28	-----	-----
1899.....	Mar. 29	Nov. 8	Apr. 10	Nov. 3	-----	-----
1900.....	Apr. 1	Nov. 9	Mar. 17	Nov. 10	-----	-----
1901.....	Mar. 17	Nov. 6	Apr. 22	Nov. 16	-----	-----
1902.....	Mar. 6	Nov. 28	Mar. 6	Nov. 28	-----	Oct. 29
1903.....	Mar. 26	Oct. 25	Mar. 26	Oct. 25	Mar. 26	Oct. 25
1904.....	Mar. 4	Nov. 11	Mar. 5	Oct. 24	Mar. 15	Oct. 21
Average.....	Mar. 22	Nov. 7	Mar. 27	Nov. 6	-----	-----

AGRICULTURE.

Cotton and corn were the principal crops produced by the early settlers of the county. Before the war, however, more diversified farming was practiced than at the present time. More of the home necessities, including fruits and vegetables, were produced, and tobacco was also universally grown for home consumption. The war temporarily changed the agriculture of the area; although corn and cotton remained the chief crops, wheat, rice, and other foodstuffs were grown. Their culture ceased, however, soon after the close of the war.

Since 1865 the agriculture of Jasper County, as that of much of the central South, has consisted of a one-crop system of farming. Cotton has been produced almost alone, corn not being grown in large enough quantities to supply local demand. Cotton did not, as is often supposed, yield heavier before the war than at the present time. As a rule, the yield was even less before the introduction of commercial fertilizers than it has been since they have become universally used. A larger area of the "prairie" types of soil was under cultivation during slavery times than at present. Because of their clayey texture and consequently more difficult tillage, these soils have been abandoned for the less fertile sandy types. Fertilizers were first introduced about twenty years ago, but they have not been generally used until within the last ten years.

Cotton and corn receive much the same treatment that they did before the war. The plowing is very shallow, irrespective of crop or soil. Very little fall or winter plowing is done, the fields generally being left bare between the harvesting and planting seasons. The ridge method of culture is commonly used for both corn and cotton. The seed bed is made by throwing two to four furrows together and subsequently harrowing with a small one-horse harrow. The fertilizer for cotton is either applied by hand while the seed bed is being prepared or drilled in as soon as completed, it often being applied two weeks or more before the cotton is planted. A standard

commercial fertilizer running high in phosphoric acid is commonly used. The application varies from 200 to 500 pounds per acre.

Corn generally receives an application of cotton seed as well as a phosphatic fertilizer, but sometimes no commercial fertilizer is used, cotton seed alone being applied. On the black prairies corn is seldom fertilized. The seed is generally drilled by hand in a furrow which has been opened up in the center of the seed bed, the fertilizer having been previously applied by hand. It is a common practice among the farmers to walk over the field and drop a handful of cotton seed in each hill, then apply a small amount of common fertilizer by hand, and finally go over it the third time and drop a few kernels of corn in each hill.

Cotton is generally planted between the 1st and the 10th of April. Some late cotton is planted in May. Corn is usually planted from the 1st to the 20th of March, though late corn, which is frequently grown, especially on the "prairies," may be planted as late as May 10.

Cotton is chopped when a week or two old and generally hoed a second time two or three weeks later. The "scraper" is used when the plants are small, and later two or three cultivations are given with the "diamond scooter." Corn is worked with a one-horse plow and seldom receives over two cultivations. The cotton is ginned at the small gins scattered throughout the county, and sold to local cotton buyers. The corn is snapped in the field, and is generally all utilized on the farm. The blades are frequently stripped from the stalks while green and tied into small bundles for forage. There is not enough corn produced in the county to supply the local demand, it being imported from the corn belt in large quantities.

Fall oats are grown to some extent, but the yield is always light. Cowpeas are about the only legume grown in the county, and this crop only in a limited way. Considerable wild hay is cut from the prairies. Sugar cane, sweet potatoes, and fruit are the other products of importance.

Because of this one-crop system of farming there is no systematic rotation practiced in the county. Cotton and corn are grown upon the same land year after year. They are sometimes rotated with each other to a limited extent, but such a rotation has very little beneficial effect. Cowpeas are frequently sown in the corn after the last plowing and are generally recognized as very valuable in improving the soil. Oats are occasionally rotated with corn or cotton. Not only does this exclusive production of cotton and corn prevent any systematic rotation, but it also prevents the adaptation of the crop to the soil. Cotton and corn are grown on practically every type of soil in the county. Corn is known to produce better on the black prairie, while sugar cane is grown on the low areas in the sandy types, where the soil is more productive and the moisture content

higher; still, little heed is given to the adaptation of soils to certain crops. The problem of securing farm labor is a difficult one, as it is in many parts of the country. The one-crop system of farming is partly to blame for this, and by adopting a more diversified system, giving a chance for more continuous employment, the labor conditions may be much improved. Where steady employment is now offered labor can be secured by the month for from \$15 to \$18 and board.

Of 294,657 acres in farms, according to the census of 1900, 82,259 acres were improved. The average size of farms in the county in this same year was 130.7 acres. This does not represent the average area owned by individuals, however, as the census classed each tenancy as a farm. There are a good many tenants who rent small areas of 10 or 15 acres, but there is little farm land owned in smaller tracts than 40 to 80 acres. There are a good many farms of 80 to 160 acres, while a rather large part of the county is owned in tracts of from 200 to 1,000 acres or more. Generally the farms are smaller in the east and in the central parts of the county. As stated, the longleaf pine forests are being rapidly cut at the present time, and the newly cleared land will probably be sold in small tracts, thus materially affecting the average size of the farms of the county. Many of the farms of 80 to 160 acres have only a small patch of ground, some 10 to 20 acres, under cultivation.

In 1900 more than 59 per cent of the farmers tilled their own soil. The crop system of renting is universally employed, the tenant giving a bale of cotton for so much land, generally what can be tended with one mule. The owner furnishes the tenant with food and other supplies until the crop is made.

The farm lands vary greatly in price, depending on the soil, the topography, the timber, the distance from a railroad station, and the improvements. The sandy types vary in value from \$5 to \$20, with an average price of about \$8 to \$10 an acre. The flat post-oak prairies sell for \$5 or less an acre, while the black calcareous prairies bring \$10 or more. The land generally has advanced greatly in price during the last eight or ten years, and in some cases it has doubled in value within the last five years. Land with a heavy growth of commercial pine is now worth \$15 to \$25, while a few years ago the greater part of the good timber land was purchased for from \$2 to \$5 an acre. The farm lands in the vicinity of the railroads are still advancing in price.

The agriculture of the county has been slowly improving within recent years. There is a tendency among the farmers to use more improved machinery. Two-horse plows are frequently seen, while ten years ago it is said they were unknown in the county. Mowers, sulky rakes, and other modern machinery are also in use.

More diversified methods of farming should be generally practiced. While cotton will probably always be the leading crop of this section, it should not be the only money crop. Where cotton is grown upon the same land years after year, much benefit will be derived from growing some winter legume after the cotton. Burr clover and vetch are well adapted for this purpose and either of these crops will make a good growth during the winter months. They can either be turned under in the spring or pastured and the resulting manure left on the land. However, a rotation involving a greater diversity of crops, as before mentioned, would prove more satisfactory to the farmer and more beneficial to the soil. A good three-year rotation, made up of crops already grown in the county, consists of cotton, corn, and oats, with a crop of cowpeas grown in the corn and another following the oats. It is very essential that in any rotation adopted, especially on the sandy types of the county, leguminous crops enter frequently. Cowpeas, melilot, lespedeza, and vetch, can all be used to advantage. Sweet potatoes and the winter cereals are also suitable for rotation in this area.

Hay production should receive more attention. Except on the Houston clay, where considerable wild hay is grown, little hay is produced in the county. Well-cured hay always brings a good price on the local market. Not enough hay is produced in many sections to feed the live stock now on the farms. Alfalfa would produce abundantly on the Houston clay, where the drainage is adequate, and it is a crop that should be introduced on this type of soil. Johnson grass gives a heavy yield of hay of fair quality on Houston clay, but the advisability of planting this grass is questionable, since it spreads rapidly and is very difficult to eradicate. Lespedeza, cowpeas, soy beans, Bermuda grass, and crab-grass should make good hay on the sandy soils, while Japanese rye-grass, orchard grass, and lespedeza are recommended for pastures.

The live-stock industry should receive more attention. The Houston clay prairies afford good pasture for eight months of the year, and as the soil is capable of producing 40 bushels or more of corn per acre and 3 to 6 tons of alfalfa hay, this region is well adapted to the production of beef cattle and dairying.

The ridge culture of cotton and corn so generally employed in the county could well be dispensed with in many cases. The practice, while perhaps necessary to keep weeds in check and hasten drainage on the Houston clay and heavy soils generally, exposes more surface of the soil to the sun and consequently increases evaporation considerably. Hence, on sandy soils, where conserving moisture is an important question, the flat culture of crops will give better results.

In the great majority of cases deeper plowing is to be recommended, especially on the clay soils. The repeated and frequent use

of the moldboard plow run at the same depth tends to compact the subsoil, forming a plowsole at the depth reached by the plow. This is often as shallow as 3 or 4 inches, and the feeding zone of the crops is thus limited and droughty conditions are induced. Deep plowing also helps materially to prevent soil washing, and should be one means, among others, employed to lessen the rapid erosion of soils on the rolling areas. The plowing under of green crops, the application of manure, or increasing in any other way the organic content of the soils, would likewise lessen the washing of the broken areas and at the same time increase their productiveness. Terracing and embanking should be employed on the slopes, and the more rolling areas should either be seeded to pastures or left in forest.

SOILS.

Originally, before the area was uplifted above sea level, the surface of Jasper County was probably covered with the Lafayette sands and gravels. This formation still makes up the surface of practically all of the south part of the county, and is generally underlain by the Vicksburg, except in the southwestern corner of the county, where the Grand Gulf formation is found.^a

Though remnants of the Lafayette may still be found on the tops of the higher hills, the materials have been largely removed from the north section of the county, exposing the clays of the underlying formations, and giving rise to what is known as the "Central Prairie Belt of Mississippi." This belt apparently represents an old shore line which existed during the period of uplift. At this time the sands and gravels were more or less washed and eroded away by wave and current action.

The soils may be divided into three distinct groups; the so-called "prairie region" of the north and east parts, the sandy or piney woods soils of the central and southern parts, and the alluvial bottoms along the streams throughout the area.

The soils of the prairie region are derived from the oldest formation in the county, and constitute three distinct series—the Houston, the Montrose, and the Susquehanna. Though they are closely associated, they are all of slightly different formation. The Houston series, represented only by the Houston clay, is the oldest of these. It is of sedimentary formation, being derived from the Eocene Tertiary limestone which underlies it. This type is locally known as "black" or "shell prairie." It is generally of a slightly rolling topography and occasionally gullied on the slopes. It is a distinctly calcareous soil and is underlain within a few feet of the surface by chalk or rotten limestone. The Montrose clay includes the greater part of the

^a Geological Survey of Mississippi. Bulletin No. 3.

clay areas of this "prairie" region. It is of slightly more recent formation than the Houston clay and is probably underlain at from 10 to 20 feet by the limestone. It possesses a characteristic flat topography and is universally poorly drained. It is locally called "flat-woods" or "hog wallow prairie," and is heavily timbered with scrubby black-jack and post oak and some pine. The subsoil is generally of a distinctly acid character, and this, along with its characteristic yellow color, distinguishes the type from the clays of the other series. The Susquehanna clay is closely associated with the Montrose clay. It seems to be of similar formation, though it very probably is of more recent origin as in almost all cases it is found overlying material like that of which the Montrose is formed. The drainage is invariably better than that of the Montrose soil, and it is very probable that this factor has been influential in causing the difference in the character of these two soils. It differs from the Houston clay in that the calcareous formation occurs at a greater depth, that the surface soil is red rather than a brown color, and that the subsoil is mottled red instead of a yellow or drab colored clay. It is not as calcareous as the Houston, nor has it the acid character of the Montrose clay. The characteristic gray and red mottled clays which give rise to this type seem to dip to the south and are frequently seen exposed under the Lafayette sands of this region. The Susquehanna series is also represented by small areas of the fine sandy loam type. The Montrose sandy loam which occupies rather level areas in this section is found closely associated with the Montrose clay. The subsoil is of very similar character, except that it is rather sandy. It is of practically the same formation as the Montrose clay. Numerous high limestone hills and ridges are also found throughout the "prairie section" of the county. These ridges are often 100 to 200 feet above the surrounding "prairies." They are generally covered by a deposit of the Lafayette sands and gravels, giving rise to soils of the Orangeburg type. The sides and frequently the depressions of these elevations present soils of the Susquehanna or Montrose series. These sand-covered ridges are frequently badly eroded, the Lafayette sands and gravels being cut through and the underlying clays exposed. There are also seeps and springs around the sides of these ridges, the water readily passing down through the sand and following the clay stratum until it emerges along the hillsides, where the contact between the two strata is exposed.

The Vicksburg and the Grand Gulf formation are exposed to some extent, but have little influence on the soils, for the reason that the surface is generally composed of a covering of Lafayette sands. The topography where the Vicksburg is the underlying formation is rolling to hilly. The streams have often cut down 50 to 75 feet into the

Lafayette. In the Grand Gulf formation, however, the surface is more level and the soil seldom badly eroded. The soils are generally of the Orangeburg or Norfolk series, the former prevailing on the high, broken divides, but giving way to the latter as the topography becomes more level. The Norfolk series is more extensively developed as one goes south, and it replaces the Orangeburg soils almost entirely in the Grand Gulf formation. The Orangeburg series includes the soils having a red sandy clay subsoil, while the Norfolk series is composed of those with yellow or orange subsoils. The variation in texture and in the depth of the surface soils of this region have given rise to numerous soil types. Orangeburg clay, loam, sandy loam, fine sandy loam, and sand, and Norfolk sandy loam, fine sandy loam, sand, and coarse sand have been found. The Norfolk series in some instances seems to be of post-pleistocene formation. Areas which are apparently of this formation are found adjacent to stream bottoms, especially in the northeast corner of the county.

The third soil region of the county, the alluvial flood plains along creeks, is of recent formation and is still being slowly modified by frequent inundations. These bottom lands present two soils of very different textural characteristics. In the "prairie" region, where the bottoms have been formed from the wash of the heavy clay types, the Ocklocknee clay is found. As the sandy section of the county is entered, the texture of these alluvial deposits changes gradually into a loam or sandy loam. In this way the Ocklocknee loam has been formed. Practically all the stream bottoms are subject to frequent inundations. They are low, and during the rainy seasons swampy. The bottoms along the larger streams are locally called swamps, but in most cases they are not true swamps. They are all heavily timbered and seldom cultivated.

The following table gives the names and extent of the several soil types encountered in the survey:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Norfolk fine sandy loam.....	96,192	22.3	Orangeburg clay.....	8,256	1.9
Orangeburg fine sandy loam.....	85,184	19.8	Orangeburg sand.....	6,656	1.5
Orangeburg sandy loam.....	52,992	12.3	Susquehanna fine sandy loam.....	6,060	1.4
Montrose clay.....	43,840	10.1	Orangeburg fine sand.....	2,304	.5
Ocklocknee loam.....	42,432	9.9	Orangeburg loam.....	1,964	.5
Ocklocknee clay.....	23,040	5.4	Norfolk sand.....	1,536	.3
Montrose sandy loam.....	20,928	4.8	Norfolk coarse sand.....	448	.1
Norfolk sandy loam.....	16,128	3.7	Total.....	431,872	
Susquehanna clay.....	12,480	2.9			
Houston clay.....	11,392	2.6			

ORANGEBURG FINE SANDY LOAM.

The Orangeburg fine sandy loam consists of a fine gray sand or sandy loam surface soil, 4 to 15 inches deep, underlain by a red sandy clay subsoil. The surface soil frequently contains some gravel and in small local areas it is covered with iron concretions and rock fragments. The subsoil is more sandy below 30 inches and is frequently of a mottled red and yellow color.

In some sections, especially in the vicinity of the Susequehanna soils, the red sandy clay subsoil of the Orangeburg fine sandy loam becomes heavier and often where it grades into the Susquehanna clay or fine sandy loam it is very plastic. Much of the Orangeburg fine sandy loam in the northeast part of the county is of this phase. In this section the deposit which gives rise to this type is very thin and frequently the underlying mottled clays, which weather into soils of the Susquehanna series, are exposed.

On the cultivated slopes the surface is badly washed in places and spots are frequently seen scattered through the fields where the red subsoil is exposed. On the other hand, at the lower edge of the slopes the sand has often accumulated to a depth greater than 15 inches.

The Orangeburg fine sandy loam is invariably a well-drained soil, the topography being rolling to very broken and hilly. A large percentage of its area is too broken for cultivation, and much of that under cultivation is eroded. Areas of this soil are found throughout the southern and central parts of the county. It gives way to the Norfolk fine sandy loam to the south as the topography becomes more level.

The Orangeburg fine sandy loam, like most of the sandy types of the area, has been derived from the Lafayette formation, which is of considerable depth in many sections. The deposit becomes deeper in the southern part of the county.

The Orangeburg fine sandy loam is one of the characteristic "piney wood" soils. Originally it was all heavily forested, mostly with shortleaf and longleaf pine, though different species of oaks are common on this soil. Much marketable pine has been cut in the county from this type, and invariably where the pine is removed and the land left idle a thick growth of post and scrub oak springs up to take its place.

The Orangeburg fine sandy loam is an excellent truck soil, being capable of producing nearly all varieties of vegetables and small fruits. Melons, strawberries, and sweet potatoes do especially well. It requires rather heavy fertilization for the cereals and for cotton. This is one of the best peach soils found in the South, and peaches and pears do well locally.

Cotton is the leading crop at present, and although commercial fertilizer is used, produces on an average hardly one-half bale to the acre. With heavier fertilization and especially careful cultivation a yield of 1 bale or more is often secured. Corn and oats are also grown, but the yields are generally light. Although corn sometimes produces 25 bushels or more, the average yield is about 12 bushels. Some cowpeas are grown either alone or in the corn. They are practically the only legume produced in the county. Sugar cane is grown in the low areas, where the wash from the hills has accumulated, but generally the soil requires heavy applications of manure to produce this crop.

The Orangeburg fine sandy loam is plowed to a shallow depth, seldom over 2 or 3 inches. The plowing generally follows the contour of the land and unplowed ridges are left on these slopes by the better farmers to prevent erosion. Generally deeper plowing should be practiced on this type and more leguminous crops should be grown and turned under. Such practices would greatly improve the productiveness of the soil and at the same time tend to lessen the damage from erosion, which is a very important matter. Many fields are already past reclamation, while others recently placed under cultivation should have been left uncultivated, as they are so broken that they will rapidly gully even with the most careful treatment.

Commercial fertilizers have been used to some extent in the cultivation of the Orangeburg fine sandy loam for the last fifteen years and are now in general use. Various brands are found on the local market. Those running high in phosphoric acid seem to give the best results. Stable or green manure is seldom used, but cotton seed has been found a valuable aid in crop production.

This is one of the best of the sandy types found in the county. It sells for from \$5 to \$10 an acre, though the broken areas distant from the railroads may be secured for less. On the other hand, the better-improved farms on this type are held at \$15 or more an acre.

The following table gives the average results of mechanical analyses of special samples of the soil and subsoil of the Orangeburg fine sandy loam:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
15511, 16733....	Soil.....	0.5	5.2	8.0	37.5	11.9	32.1	4.5
15512, 16734....	Subsoil.....	.3	3.3	5.5	29.3	7.8	24.8	29.1

ORANGEBURG SANDY LOAM.

Like the preceding type, the Orangeburg sandy loam consists of a sand or sandy loam surface soil, 4 to 15 inches deep, underlain by a

red sandy clay subsoil. The sand of both the surface and subsoil is coarser than that of the Orangeburg fine sandy loam. The surface is often of yellowish to brown color, while on the slopes the subsoil is of a deeper red color and of a slightly looser structure than that of the fine sandy loam type. The surface soil is very low in organic matter, except in depressions, where the humus content runs fairly high. The soil is more fertile and produces larger crops where the subsoil is within 6 or 8 inches of the surface.

The Orangeburg sandy loam is very closely associated with the Orangeburg fine sandy loam. They have been formed in practically the same manner, the difference in texture being due largely to the differences in the rapidity of the currents at the time of deposition.

The Orangeburg sandy loam is found in areas of varying size throughout the county. It occupies large areas around Pauling and forms one of the common types on the sand ridges in the north part of the county. The topography is often very rough and much of this type is badly gullied. It is naturally a well-drained soil, but owing to the hilly character of the surface, a considerable proportion of the area can never be put into cultivation.

Not only is the natural vegetation nearly identical with that of the Orangeburg fine sandy loam, but the crops adapted for cultivation are also similar. The timber consists largely of shortleaf pine and is of less commercial importance than either the shortleaf or longleaf pine found on the Orangeburg fine sandy loam. It is not as good a truck soil as the Orangeburg fine sandy loam, but like it, it is an excellent peach soil, and in some sections of the south it has proved a fine soil for growing a high-grade cigar tobacco. As found in this area, however, it is probably not as well adapted to tobacco as in some other sections of the country.

Cotton and corn are the leading crops, the former yielding from one-third to 1 bale and the latter from 8 to 25 bushels per acre. Cowpeas produce well. The crop yields in general are about the same as on the Orangeburg fine sandy loam, though on the whole corn and cotton do a little better. There is an impression among the farmers that this soil is more readily affected by drought than is the Orangeburg fine sandy loam. This would naturally be expected on account of the coarser, more sandy surface and the looser structured subsoil.

This soil is usually fertilized for corn and cotton, commercial fertilizer and cotton seed being applied to the first-named crop and commercial fertilizer alone to the latter. Few legumes are grown and little organic matter turned under.

The Orangeburg sandy loam is generally valued at \$5 to \$10 an acre. Near the Orangeburg loam areas, where the surface is less

sandy, it sells for as high as \$15, while the very rough areas can be bought for less than \$5 an acre.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of the Orangeburg sandy loam:

Mechanical analyses of Orangeburg sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16729, 16781.....	Soil.....	2.6	18.9	16.6	31.7	8.0	24.7	4.3
16730, 16732.....	Subsoil.....	.8	12.7	14.1	23.3	1.7	24.6	22.8

ORANGEBURG CLAY.

The surface soil of the Orangeburg clay is rather variable. It frequently consists of from 4 to 6 inches of brown to red sandy loam or sandy clay, but sometimes there are 2 to 4 inches of sand or fine sand on the surface, while again the surface may be a heavy sandy clay nearly identical with the heavy red clay or sandy clay which forms the subsoil.

This soil is locally known as red prairie land, and although most of it has been timbered, some few areas were naturally open prairie. It occupies gentle to rather steep slopes adjoining streams, and the surface is always rolling enough to give good drainage.

Some areas of the Orangeburg clay are unquestionably derived from the Lafayette formation and owe their origin to the washing away of the finer surface sand materials, which weather to form the Orangeburg sandy loam and the Orangeburg fine sandy loam. Other areas seem to be of different origin, since they are underlain by limestone. The area southeast of Heidelberg is of this character.

The Orangeburg clay is found most extensively in the southeastern part of the county in the vicinity of Heidelberg, and occurs only in small scattering areas in other sections of the county. Where well tended it is very productive, and is better adapted to the growing of corn than are the other Orangeburg soils of the county, with the possible exception of a few small areas of Orangeburg loam. It is also a very good cotton soil, but requires thorough and careful cultivation to maintain a good tilth. With careful treatment most of the Orangeburg clay could be made to produce a bale of cotton to the acre. At present cotton and corn are about the only crops grown. Corn yields 15 to 30 bushels and cotton from one-third to three-fourths bale per acre. The greater part of the type is still in timber, while some is used as pastures.

The Orangeburg clay receives the same cultural treatment and practically the same fertilizers, though in smaller amounts, as are used on the sandy soils. It is much more difficult to get into condition for a

crop than are the sandy types, and it can not be worked as soon after a rain as the more open-textured soils.

Owing to the unimproved condition of this soil it has generally a low value, selling for \$4 to \$10 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of the Orangeburg clay:

Mechanical analyses of Orangeburg clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
16737-----	Soil-----	0.9	2.8	3.5	20.2	2.8	42.1	27.6
16738-----	Subsoil-----	1.0	1.2	1.2	8.1	1.8	31.5	56.0

ORANGEBURG SAND.

The Orangeburg sand, as found in this area, consists of brown to yellow sand having a depth of 12 inches or more, which grades into a brown or red sandy loam, in turn underlain by a red sandy clay or a red sand. Frequently the stratum of sandy loam is absent, and the soil in that case consists of a medium sand from 15 to 30 inches deep, underlain by a red sandy clay subsoil. In this case it is identical with the Orangeburg sandy loam, except that the surface soil is of greater depth.

The Orangeburg sand is not a very important type of soil in Jasper County, the total area being only a few square miles. It is frequently found on the steep slopes along small streams, while much of it is closely associated with the Orangeburg sandy loam, occupying areas where the surface sand has a depth of over 15 inches.

There is little doubt that most of this type occurring in the county is formed from the Lafayette the same as the other types of the Orangeburg series. It seems hardly reasonable to attribute this deeper deposit of sand wholly to any one cause, since, in some places it appears to have been formed by the deposition of a deep layer of sand, while in other places there are indications of the clay having been wholly or partly removed by drainage waters, leaving a sandy stratum on the surface. The surface is generally rolling to hilly, and, with the open texture, this secures good drainage. In its native state the Orangeburg sand was forested with shortleaf pine and oak. The pine generally is of rather stunted growth and of little commercial importance.

Very little of the type is under cultivation at the present time. The soil is fairly well adapted to peaches, where underlain by red sandy clay within 2 or 3 feet of the surface. Corn and cotton are produced upon this soil, but they generally require heavy applications of fertilizer, and are more quickly affected by drought than on the

sandy loam soils. Watermelons and sweet potatoes produce well, but most of the other vegetables suffer during dry spells. This droughty condition could be lessened by the application of well-rotted stable manure or other forms of partly decayed organic matter. Even by better cultural methods alone much moisture that now evaporates could be conserved.

It is difficult to place an average value on this soil, since it is found in such small areas. Generally the value runs a little lower than that of the Orangeburg sandy loam, varying from \$3 to \$8 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Orangeburg sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16725 -----	Soil -----	1.3	20.3	26.7	31.0	6.5	9.1	5.0
16726 -----	Subsoil -----	1.2	16.9	19.2	20.8	5.1	13.5	23.5

ORANGEBURG FINE SAND.

The surface soil of the Orangeburg fine sand is a fine sand to fine sandy loam having an average depth of about 24 inches. In texture it is practically identical with the surface of the Orangeburg fine sandy loam, the separation being based upon the greater depth to the subsoil. The subsoil consists of a red fine sandy clay.

There are only a few patches of this soil in the county, and only two areas of any size, one just south of Louin and the other about 5 miles east of that town. The Orangeburg fine sand is generally rolling and well drained. It is still practically all timbered with good commercial longleaf pine, but it should make a good truck soil. It is rather light for cotton and corn, though by careful cultivation and heavy fertilization fair yields of cotton can be obtained.

At the present time this soil is valuable on account of the timber upon it, but without this it would probably be valued at \$4 to \$8 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Orangeburg fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16727 -----	Soil -----	0.0	0.4	2.4	59.9	11.2	21.9	3.2
16728 -----	Subsoil -----	.0	.3	1.4	43.2	7.9	14.4	32.8

ORANGEBURG LOAM.

The Orangeburg loam consists of about 12 inches of brown loam resting on a subsoil of a light-textured red sandy clay or heavy loam. The character of the surface soil varies somewhat with the topography, tending, on the slight elevations, toward a sandy loam, and, in the depressions or level areas, toward a silt loam.

There are only a few small areas of this soil. It occurs in the vicinity of Lake Como and also in a few places in the northeast part of the county. It occupies gently rolling areas, somewhat resembling table-lands. The drainage is generally adequate, and seldom is the topography rolling enough to cause erosion.

The areas of the Orangeburg loam are generally well improved, and some of the most highly improved farms in the county are seen on this soil. It is productive and adapted to a great variety of crops. Corn and cotton both produce well. The yield of oats is also good. It is not as early a soil as some of the more sandy types, but it is naturally more productive, as its loamy nature gives it a better water-holding capacity, while the more level topography prevents erosion and allows the use of modern machinery.

A higher valuation is placed upon this type of soil than upon any other in the county. It is held at from \$10 to \$30 an acre, the difference in price depending upon the improvements.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Orangeburg loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16735 -----	Soil.....	0.6	14.5	16.1	16.8	0.6	39.1	12.0
16736 -----	Subsoil.....	.3	13.8	14.6	16.8	.6	34.8	19.2

NORFOLK FINE SANDY LOAM.

The surface soil of the Norfolk fine sandy loam consists of a gray or yellow fine sand to fine sandy loam, with an average depth of about 15 inches. The surface 6 to 10 inches is a gray fine sand which grades into a more compact pale-yellow fine sandy loam, and this, in turn, at from 12 to 20 inches, into the yellow or light orange sandy clay subsoil. Below 30 inches the subsoil becomes mottled, and in the more level areas this mottling occurs throughout the profile below the soil. The yellow subsurface stratum, while often abnormally developed, is frequently almost entirely absent, in which case the gray fine sand rests directly upon the yellow subsoil. In the virgin state the surface 2 or 3 inches contains considerable organic matter and is often of a brown

color and of a heavy texture, but when cropped for a few years these characteristics disappear. There are some small areas scattered through this type where the surface soil contains iron concretions and quartz gravel, while occasionally ferruginous sandstones are mixed with the finer material throughout the profile.

The Norfolk fine sandy loam occurs in nearly every township in the county. It is generally associated with the Orangeburg fine sandy loam, occupying the more level areas. In the south part of the county, below the base line, it is the predominating type of soil. The topography is generally rolling, seldom becoming too rough for cultivation, while the many level areas are generally well drained. The more broken areas are eroded somewhat, but this type is not generally as badly washed as is the Orangeburg fine sandy loam. In most cases this soil is derived from the Lafayette formation, as is the Orangeburg fine sandy loam; the marked difference in color and the slight difference in texture being due partly to different drainage conditions. There are, however, adjacent to streams, some rather flat areas of this type, which seem to be derived from Pleistocene deposits, having resulted from the weathering of an old alluvium. In the southwestern part of the county this type of soil seems to have been formed from certain materials of the Grand Gulf formation. The areas are generally timbered with longleaf and shortleaf pine. In the southwestern part of the county, especially, heavy growths of the longleaf pine are found. These forests are being rapidly removed and the partly cleared land generally left to grow up in post and black-jack oak.

The crops produced and yields are similar to those of the Orangeburg fine sandy loam. It is generally recognized that the Norfolk fine sandy loam is not as productive, under the same conditions, as is the Orangeburg fine sandy loam. However, there is little difference in the agricultural value of these two types in Jasper County, since the Norfolk fine sandy loam is generally more level and consequently is more economically cropped.

This can not be considered as an especially good corn and cotton soil, yet these two crops are almost exclusively grown upon it. They both receive annual applications of fertilizer at the rate of from 200 to 400 pounds per acre. Cotton produces from one-fourth to three-fourths of a bale and corn from 8 to 20 bushels per acre. Frequently larger yields than these are obtained, but it is only where the soil has received especially good treatment.

The Norfolk fine sandy loam is a good truck soil and the few vegetables grown upon the type in this county produce well. Fruits, including peaches, figs, pears, and the small fruits, also do well.

As in the case of the other light sandy soils of the county, the Norfolk fine sandy loam is naturally deficient in organic matter, and

that which exists in the surface few inches of the virgin soil is exhausted by a few years cropping to corn or cotton. Barnyard manure is especially beneficial, and leguminous crops, such as cowpeas, soy beans or lespedeza, should be adopted as a regular part of the crop rotation, and as far as possible turned under or fed to live stock and the manure returned to the soil.

Where improved this type sells for \$8 to \$10 or more an acre. The unimproved areas from which the commercial pine has been removed, can be bought for \$5 an acre.

The following table gives the results of the mechanical analyses of samples of soil and subsoil of this type:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16721 -----	Soil -----	0.1	0.7	1.4	52.4	10.8	30.1	4.7
16722 -----	Subsoil -----	.1	1.1	1.8	32.5	8.0	33.3	22.5

NORFOLK SANDY LOAM.

The Norfolk sandy loam consists of a gray sandy loam surface soil with an average depth of about 15 inches, resting upon a subsoil which to the depth of 36 inches is a yellow sandy clay or sandy loam. Where the drainage is poor this subsoil frequently becomes a mottled gray and has some iron concretions scattered through it. The surface few inches of the virgin soil often contains considerable organic matter, but this is rapidly exhausted by cultivation and the soil becomes low in humus.

Two distinct phases of this type are found in the county—that occupying rolling areas and consequently well drained, and that found on the level, poorly drained areas adjacent to the streams. The latter phase frequently has a rather heavy subsoil where adjacent to the Montrose clay areas and resembles in some ways the Montrose sandy loam.

The Norfolk sandy loam is found most extensively in the north-eastern part of the county. In the vicinity of Rose Hill and Hero there occur gently rolling areas of this soil that are well improved and in a good state of productiveness. Frequently these areas tend toward a loam in character and resemble somewhat the Orangeburg loam. The flat areas along the streams are poorly drained and are seldom farmed. Practically all these areas can be put under cultivation if properly drained.

The rolling areas of Norfolk sandy loam seem to be derived from the Lafayette formation, having practically the same origin as the rolling areas of Norfolk fine sandy loam. The low, flat areas along

the streams also are of similar formation as the corresponding phase of the Norfolk fine sandy loam, seeming to owe their origin to a Pleistocene alluvial deposit of the streams.

A very large part of the gently rolling phase of the Norfolk sandy loam is under cultivation, but the lower areas are still heavily timbered. Cotton forms the leading crop and where the drainage is good yields from one-third to three-fourths bale per acre. The yield of corn is only 10 to 15 bushels per acre, being relatively lower than that of cotton. On the more loamy areas larger yields of both these crops are obtained. Oats do not do as well on this type as on the Orangeburg sandy loam. The type is well adapted to vegetables and the more rolling areas to fruit.

Farms of this soil bring from \$5 or less to \$25 an acre. Some of the best farms of the county are found on this soil.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Norfolk sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
16719 -----	Soil -----	0.9	4.9	9.6	37.1	10.4	32.0	4.9
16720 -----	Subsoil.	.3	2.0	7.6	33.6	9.8	31.4	14.4

NORFOLK SAND.

The Norfolk sand is of practically the same texture throughout the 3-foot profile. It is a nearly pure quartz sand, containing little material finer than fine sand and seldom any large quantity coarser than medium sand. The surface 6 inches is a grayish yellow, though frequently a light-brown shade is found, owing to the presence of a small quantity of organic matter. There is seldom enough, however, to give the material a loamy texture. The subsoil has a yellow color.

This soil occurs as hills and ridges, many of which resemble sand dunes, and it is possible that the wind has played an important part in its formation. The sand itself is traced to the Lafayette formation, but it is very probable that these deep deposits have been formed by more recent forces which have materially changed the character of the original deposits.

The Norfolk sand is of minor importance, occupying only a few small areas, most of which are situated in the immediate vicinity of Paulding or southeast of this place. Very little of the type is cultivated. It is generally timbered with a light growth of scrubby black-jack and post oak and a few scattering pines. It is too light a soil for the common farm crops, but by heavy applications of commercial fertilizer and organic matter it could be made a fair truck soil. It is

naturally droughty, owing to its deep, loose subsoil. This type can be bought for a few dollars an acre.

The following table gives the results of mechanical analyses of samples of soil and subsoil of this type:

Mechanical analyses of Norfolk sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
16715 -----	Soil-----	0.3	8.2	48.1	36.5	1.4	3.2	2.9
16716 -----	Subsoil-----	.2	9.1	48.0	36.9	1.2	2.5	2.3

NORFOLK COARSE SAND.

The Norfolk coarse sand consists of a yellowish coarse sand 36 inches or more in depth. A surface layer a few inches in depth contains a very small quantity of clay—just enough to hold the sand particles together when wet. There is often a small quantity of organic matter in the top soil, which gives it a light-brown color, but there is no marked difference in the material throughout the profile. The type contains considerable gravel scattered through it, and a few small gravel beds occur. In some areas the subsoil is cemented into a ferruginous sandstone or conglomerate. The type is generally underlain at from 3 to 20 feet by a red gravelly or sandy clay. In some cases, however, it seems to have been deposited under the red clays of the Orangeburg series and forms the surface soil on the slopes where these clays have been eroded away. It is very similar to the preceding type, differing from it mainly in the proportion of sand of coarser grades.

The type is of very local occurrence, being found in small areas on the ridges in the vicinity of Baxter. It is seldom farmed and has very little agricultural value.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Norfolk coarse sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
16717 -----	Soil-----	6.4	61.1	18.4	5.9	1.8	3.4	3.3
16718 -----	Subsoil-----	11.1	56.9	19.6	5.5	1.3	3.3	2.7

HOUSTON CLAY.

The Houston clay, to a depth of from 4 to 12 inches, is a light-brown to black heavy clay loam. It is shallow and of a yellow color on the higher areas, while along the gentle slopes it is deeper and of a

brown to black color. The surface is frequently covered with lime concretions and Tertiary shells. When wet the surface becomes very sticky, but upon drying the lime causes flocculation of the clay particles and it assumes a loose granular structure. The subsoil consists of a yellow calcareous clay or a gray chalky limestone. This chalky clay is generally within 3 feet of the surface and over much of the type there are gray spots where this material practically forms the surface soil. Such areas are low in organic matter and not as productive as where the surface soil is deeper and darker in color. In the ravines the underlying limestone rock is occasionally exposed.

When wet this soil is difficult to cultivate, but when the moisture conditions are favorable it is a very friable soil. This is largely due to its high lime content, but the relatively large proportion of organic matter generally present also has a marked influence upon the tilth.

The Houston clay occupies gently rolling areas in the north-central part of the county. They are seldom more than a few square miles in extent and are usually surrounded by either the Montrose clay or the Susquehanna clay. The surface drainage is generally good. Many of the slopes where the run-off is rapid have been allowed to gully until they are almost worthless.

The Houston clay is a residual soil, having been derived from the disintegration of Tertiary limestone. This limestone may be seen in nearly all stages of disintegration in the numerous exposures in cuts and ravines. The same Tertiary shells are found in the underlying limestone as in the surface soil. This limestone probably belongs to the Jackson stage of the Eocene Tertiary.

The Houston clay areas are commonly spoken of as bald prairies. They were originally partly timbered, though much of the area was naturally open and covered with a heavy growth of prairie grass. The greater part of the forested area was originally covered with sturdy-growing black-jack oak, shortleaf pine, and wild plum. As soon as cleared the land naturally seeds to wild prairie grasses. At the present time sweet clover (*Melilotus alba*) may be seen growing wild on the prairies.

This is an exceptionally good corn and hay soil. It is not only adapted to the growing of grasses, but likewise to leguminous crops. Melilotus, vetch, cowpeas, and alfalfa all give heavy yields. It also affords excellent pasturage for the greater part of the year. Because of this wide crop adaptation, the Houston prairies are well suited to the live-stock industry, though at present this line of farming is receiving little attention.

Very little of the type is cultivated, the greater part of it being used as pasture or mowing land. During early times it was exten-

sively farmed, but since the war it has gone out of cultivation. Corn is the principal crop produced and yields from 20 to 40 bushels per acre. Cotton is also grown to some extent on the deeper phase of the type. The yield under careful methods of cultivation varies from one-half bale to 1 bale per acre. Much wild grass is cut for hay, but the greater part of this soil is used for pasture. A few fields of alfalfa were seen. This legume gives in a single season from 3 to 5 cuttings of about 1 ton to the acre each.

The soil is seldom well prepared for the crops. Corn is frequently dropped on the unbroken surface and a furrow plowed over it, and seldom receives more than two cultivations. Fertilizers are rarely used. There is a great chance for the employment of improved methods. Deeper plowing and a more thorough preparation of the seed bed should be practiced. Corn should receive more frequent tillage with improved surface cultivators. Alfalfa and other legumes could well enter more often in the crop rotation. Stock raising offers an excellent opportunity for the development of the Houston clay area.

There are practically no farm improvements on the Houston clay. Where farmed, the owner lives on some adjoining sand ridge, where good water may be secured. Desirable water can not be had in shallow wells in the Houston clay, and this fact, along with the muddy roads, makes this soil undesirable as a site for the homestead.

The price of this type has advanced within the last few years, but it can still be secured for from \$5 to \$10 an acre.

The following table gives the average results of mechanical analyses of samples of this type of soil:

Mechanical analyses of Houston clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16707, 16708----	Soil-----	0.1	2.5	3.3	9.0	3.2	47.6	34.6
16708, 16710----	Subsoil-----	.2	.8	1.3	13.9	7.1	48.7	27.6

The following samples contained more than one-half of 1 per cent calcium carbonate (CaCO_3); No. 16708, 42.68 per cent; No. 16709, 2.04 per cent; No. 16710, 16.61 per cent.

MONTROSE CLAY.

The Montrose clay consists of a grayish-drab clay, with a depth of from 2 to 6 inches, underlain by a yellow or yellow and gray very plastic clay, which generally becomes mottled red and gray below 20 inches. The subsoil is very heavy and has a somewhat greasy feel when wet. The surface sometimes has an inch or two of sandy loam covering.

This type occupies flat, poorly drained areas throughout the "prairie section" of the county. It is locally called "hog-wallow prairie." It has received this name because of the numerous low places scattered through it, which in size and shape resemble hog wallows. The drainage is poor, water standing in the depressions for weeks at a time during wet weather. In summer the soil dries out and cracks badly. Because of the very clayey texture of both the surface and subsoil and the very low humus and lime content, this soil is very difficult to cultivate. The poor drainage also prevents its being put into cultivation. The small tillage implements now in use in the county are inadequate for working a soil as heavy as this one.

The Montrose clay is derived from the Jackson Eocene formation. It appears to be similar in this respect to the Susquehanna clay, though in some instances it apparently has been derived from older sediments. Where associated with the Susquehanna clay it immediately overlies material similar to that forming the Houston clay. Like the other clay types, it has probably been covered by the Lafayette at some past time, but by wave and current action these materials were subsequently removed.

The type is generally timbered with scrawny post and black-jack oak. Some shortleaf pine and other species of oak are also found. The oaks have a characteristic tall and open form of growth, but as the soil becomes darker and more calcareous, as it does adjoining the Houston clay area, the trees assume a more sturdy growth and are less open and spindling. Practically none of this type is farmed. This is due partly to the great outlay necessary to clear and prepare the land. The roots of the trees have not penetrated down into the subsoil, but have spread just below the surface, forming a thick network that is very difficult to remove.

The Montrose clay is not a productive soil. It will produce one or two good crops of corn when first cleared, but the yield quickly declines. The area under cultivation is so insignificant that it is difficult to determine anything definite as to the crop production. Similar methods of culture are employed on this type as on the sandy lands of the county. The soil is generally distinctly acid, as shown by litmus tests. The application of manure and lime or of lime and green vegetable matter would greatly improve the physical condition of the soil. Much of it would first have to be thoroughly drained, however, before it could be brought into cultivation. The Montrose clay has a low agricultural value at present and can be bought for from \$2 to \$5 an acre.

The following table gives the average results of mechanical analyses of this type of soil:

Mechanical analyses of Montrose clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16711, 16713....	Soil.....	1.0	2.7	2.8	5.8	2.4	50.6	34.3
16712, 16714....	Subsoil.....	.2	1.8	2.1	6.3	3.4	46.0	35.3

MONTROSE SANDY LOAM.

The Montrose sandy loam has a gray sand or sandy loam surface soil varying in depth from 4 to 16 inches. The sand is frequently rather coarse in texture and some gravel is commonly present. The immediate surface and extending to a depth of a few inches is very often of rather dark brown color, the result of the accumulation of organic matter. The subsoil consists of a plastic gray and yellow or gray and red mottled sandy clay, the proportion of red coloring generally increasing with depth.

This type of soil is found scattered through the so-called "prairie region." Large areas occur in the vicinity of Montrose. It has also been found in the northeastern part of the county, where it occupies flat areas adjacent to Twistwood and other creeks. It is closely associated with the Montrose clay, occupying the higher, better-drained areas, yet the topography is generally level and frequently the drainage is inadequate. This is especially true of some of the narrow strips along the streams. These areas, locally known as hummocky or canebrake land, are covered with water for days at a time during rainy periods. The better-drained areas around Montrose are timbered with a fine growth of longleaf pine. There is less commercial pine on the type in the northeast part of the county, it being replaced largely by oak.

The Montrose sandy loam owes its origin to the same geological formation, the Jackson Eocene, as the Montrose clay. Sand and gravel have been deposited with the mottled clays in the case of this type and have caused the present textural difference between it and the Montrose clay.

Practically all of the type is still in timber, there being only small patches here and there under cultivation. Cotton is the principal crop grown, but seldom produces over one-third to one-half bale per acre. Some corn is also grown, but after the first few crops the yields are low. The type is not as productive as the Orangeburg and Norfolk sandy loams, and because of its low, wet nature it is not so desirable an agricultural soil. Vegetables will do fairly well on it, but it is not adapted to fruit.

The areas of this type of soil are valued principally for their timber. The better areas sell for from \$10 to \$25 an acre. Agriculturally the land is valued at from \$2 to \$5 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Montrose sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16739	Soil	3.9	15.6	16.2	22.9	1.7	32.2	7.7
16740	Subsoil	2.4	12.6	9.7	15.1	1.8	32.3	26.0

SUSQUEHANNA CLAY.

The surface soil of the Susquehanna clay, which has an average depth of about 6 inches, consists of a red or slightly red and gray mottled plastic clay. The top 2 to 4 inches is often a brownish clay loam and frequently a sandy or gravelly clay. The sandy or gravelly covering occurs where the type adjoins sand-covered hills. The subsoil to a depth of 36 inches is a mottled red and gray or red and yellow plastic clay. It generally becomes more gray or yellow below 24 inches and in some instances the red mottlings almost entirely disappear. The subsoil is frequently underlain by rotten limestone, which is occasionally found within 36 inches of the surface. Owing to its red surface it is locally called "red prairie."

The areas of this soil are generally rolling and often too rough for good farming land. Because of this topography and of the heavy surface soil cultivation is very difficult. The application of lime or stable manure or the turning under of green crops would improve the soil in this respect. The Susquehanna clay seems to have practically the same origin as the Montrose clay, though there are indications of its being of rather more recent origin. The differences between it and the Montrose clay are due probably more to difference in drainage conditions than in the materials from which they are derived. When associated with the Montrose clay, it occupies the higher, better drained areas and is never found underlying the Montrose soils. It also seems closely associated with the Houston clay, which it often surrounds in narrow strips.

The Susquehanna clay does not occur in large areas, but is found here and there throughout the "prairie region," where the mottled clay may be seen outcropping around the sides of most of the hills. Very often these areas around the sand hills are too narrow to be indicated on a map of the scale used in the survey. The type is also found occupying clay hills which have little or no sand covering.

The same mottled red and gray clay is seen throughout most of the central and southern parts of the county, outcropping from beneath the Lafayette sand and gravel.

Very little of the type is farmed, most of it still being forested with oak and shortleaf pine. It is not as productive as the Houston prairies, but gives higher yields than the Montrose clay. Corn yields from 10 to 25 bushels and cotton from one-fourth to one-half bale per acre. It is considered of low agricultural value and sells for from \$3 to \$5 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Susquehanna clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16743 -----	Soil.....	1.4	5.3	2.8	2.5	0.2	17.1	70.4
16744 -----	Subsoil.....	.3	1.2	.7	.9	.3	11.9	84.2

SUSQUEHANNA FINE SANDY LOAM.

The surface soil of the Susquehanna fine sandy loam consists of a gray fine sand or fine sandy loam having a depth varying from 4 to 16 inches and averaging about 12 inches. This is underlain by a very heavy reddish clay which becomes distinctly mottled red and gray below 20 inches. There is sometimes a relatively small quantity of sand in the subsoil. This is not an important type of soil, there being only a few rather small areas in the county. The larger of these occur southeast of Louin and northeast of Rose Hill, along Twistwood Creek. They occupy rolling to hilly country and are always well drained. Much of this soil is still timbered and considerable commercial longleaf pine is found on the areas southeast of Louin.

The surface soil of the Susquehanna fine sandy loam is practically identical with that of the Orangeburg fine sandy loam and has probably been derived from the same formation—the Lafayette. The subsoil, however, consists of the heavy red and mottled clay which underlies much of the Lafayette at varying depths.

The crops grown and the yields obtained are similar to those of the Orangeburg fine sandy loam. The soil is well adapted to vegetables and small fruits. The humus content is at present low and the cultivated areas would be greatly benefited by the growing and turning under of leguminous crops. Cotton yields about one-third to one-half bale and corn 10 to 15 bushels per acre. Land composed of this type of soil may be secured for \$5 to \$8 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Susquehanna fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16741 -----	Soil -----	0.0	0.3	0.6	40.4	12.1	40.5	5.6
16742 -----	Subsoil -----	.1	.3	.1	1.4	2.5	41.4	53.6

OCKLOCKNEE CLAY.

To a depth of 6 to 10 inches the Ocklocknee clay consists of a brown to light-drab clay or clay loam and below this depth of a heavy yellow or yellow and gray clay, which is frequently mottled with red in the lower depths. With the present poor drainage conditions cultivation of this soil is seldom practicable.

This type should receive careful culture even where well drained, for it bakes and puddles if worked when wet, and it often takes two or three years to overcome the injury done by one plowing. The Ocklocknee clay includes the first bottoms along the streams in the "prairie region." These bottoms, nearly a mile wide in places, are low, flat, cut by old channels and bayous, and subject to frequent overflows. On the whole, however, it has better drainage than the Ocklocknee loam.

This soil is of recent alluvial formation, resulting from the deposition by the streams of the clay carried from the surrounding "prairie" types. It is generally heavily timbered with gum, hickory, white and water oak, and some shortleaf pine and magnolia. Practically none of the type is under cultivation. If drained it would prove a productive cotton and corn soil, though excepting those areas resulting from the wash of the Houston prairies, which have a darker surface and give higher yields, it is not as productive as in some other parts of the State. The dark-colored phase occurs in rather large areas along the upper courses of Twistwood Creek. Some excellent pastures are to be found on this soil along a few of the small streams, but as a rule it is held at a low value at the present time, and will be used but little for agricultural purposes until the creeks are put under better control and the drainage improved. From \$3 to \$10 an acre is asked for land of this type of soil, the price depending upon the character of the timber growth.

The following table gives the results of mechanical analyses of samples of soil and subsoil of this type:

Mechanical analyses of Ocklocknee clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16745 -----	Soil-----	0.1	0.6	0.7	3.6	1.4	46.0	47.4
16746 -----	Subsoil-----	.0	.1	.2	.9	1.8	42.3	54.4

OCKLOCKNEE LOAM.

The surface soil of the Ocklocknee loam consists of a brown sandy loam to heavy loam having a depth of from 4 to 8 inches. This is underlain by a yellow and gray or brown and gray mottled sandy clay or sandy loam. Red mottlings are sometimes present below 24 inches. Frequently pockets of sand occur in the subsoil, while small areas may be found where the surface consists of a nearly pure yellow or brown sand. In other instances very distinct stratification is found, there being alternate layers of sand and sandy clay or sandy loam throughout the profile. The surface soil contains only a moderate quantity of humus and for this reason the type does not seem to be as productive as it has often been found to be in other areas.

The Ocklocknee loam occupies the flood plains of the creeks in the south and central parts of the county. It is also found in some of the creek bottoms in the northeastern part. The bottom land along the larger streams is often nearly a mile in width. The soil is formed by the wash of the sandy soils of the Lafayette uplands and consequently occupies the creek bottoms flowing through this formation. It grades into the Ocklocknee clay toward the "prairie section" of the county.

The surface is level, though it is frequently cut by old channels and bayous. Along the larger streams the bottoms are very low and flat and subject to frequent inundation. They are more or less swampy during the rainy seasons. Along the minor creeks in the central part of the county the type is not so flat and parts of it are subject to overflow only at times of exceptionally heavy rainfall. In the southern part of the county, however, all the creek bottoms are low and somewhat swampy.

Practically all the Ocklocknee loam is still heavily timbered. Some small areas along the minor streams are farmed. The timber consists of white and water oak, gum, hickory, magnolia, shortleaf pine, and a dense growth of underbrush. Because of the heavy timber growth and the frequency of overflow, it would require large expenditures to put it into cultivation and prevent injury to crops by inundation. The soil when well drained will produce good crops of both corn and cotton.

At present this type is valued only for its timber. Much of the hardwood is being cut and utilized for the manufacture of barrel staves and wagon spokes.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Ocklocknee loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
16705 -----	Soil.....	0.2	0.3	1.3	36.6	11.6	27.3	22.6
16706 -----	Subsoil.....	.0	.2	1.5	41.7	13.1	19.2	23.4

SUMMARY.

Jasper County, Miss., is situated southeast of the center of the State. It has a total area of 431,872 acres, or about 675 square miles.

In general the topography is rather broken. Level "prairie" areas intermingled with high clay hills and sand hills occur in the north part, while the high divides in the central and eastern sections are very pronounced. The entire area is drained by small creeks, the more important of which head in the "prairie section" of the north part of the county and flow in a south or southeasterly direction.

The greater part of the area is still heavily timbered. Much short-leaf and longleaf pine and some marketable hardwood may still be found in the county. Lumbering is one of the chief industries.

The population consists mainly of native-born whites and negroes. The towns are small, the largest not exceeding 1,000 population. The Mobile, Jackson and Kansas City Railroad runs north and south through the western part of the county and the New Orleans and Northeastern passes through the southeast corner.

The climate is healthful, especially in the upland sections. The winters are mild, the summers long and hot. The rainfall is sufficient for agricultural purposes and generally well distributed throughout the year.

Cotton and corn form the chief products of the farms. The former is the money crop. Oats, sugar cane, sweet potatoes, fruit, and vegetables are produced for home consumption. With the exception of hogs, very little live stock is raised in the county. Fertilizers are universally used on the sandy types for corn and cotton. Much of the farm labor is done by negroes.

There are three distinct soil sections in the county—the "prairie" section of the north and east parts of the county, the sandy section, and the alluvium along the streams. The "prairie" section is largely made up of heavy clay soils, the Montrose, Houston, and Susquehanna clays being the most important types. They are of older formation

than the soils of the sandy hill regions, and have been derived from the Jackson Eocene.

The Montrose and Susquehanna series are timbered with black-jack and post oak. The Montrose clay is generally flat, poorly drained, and of an acid nature. It is locally called "hog-wallow prairie." These two series are of little use for agricultural purposes at present.

The Houston clay is found on the open prairies or those timbered with sturdy growing black-jack oak. It is a distinctly calcareous soil, being underlain by chalk or rotten limestone, which frequently comes within a foot or two of the surface. Considerable wild hay is produced on this type. It is the best corn soil in the county, yielding 25 to 40 bushels where carefully cultivated. It gives good yields of cotton with little fertilization. It is capable of growing excellent alfalfa.

Some level sandy areas with heavy mottled subsoils occur in this section and have given rise to the Montrose sandy loam. This type is closely associated with the Montrose clay. It is of little agricultural value at present.

There are also some high limestone hills and ridges scattered through the "prairies." These are covered with Lafayette sands, and the soils are similar to those in the south part of the county.

The soils of the central and south parts of the county are derived from the Lafayette formation and are generally of a distinctly sandy nature. The Orangeburg and Norfolk series occur in this section. The former comprises soils with a red and the latter soils with a yellow sandy clay subsoil.

These sandy soils run very low in humus and require continual fertilization for the production of cotton and the grain crops. In the more rolling areas the soils of these two series are badly eroded. The surface sands vary in depth and coarseness, giving rise to fine sandy loams, sandy loams, and sand.

The Orangeburg fine sandy loam is extensively developed. It is a good vegetable and fruit soil. Cotton and corn give only fair yields.

The Orangeburg sandy loam is similar to the fine sandy loam except that the sand is of coarser texture. It is adapted to about the same crops and gives the same yields as the Orangeburg fine sandy loam.

The Orangeburg clay is a heavy red clay soil. It gives fair yields of corn and cotton where well tended.

The Orangeburg loam, fine sand, and sand are other types of this series. They occur only in small areas. The former is one of the most productive soils of the county. The fine sand and sand are light soils and of lower agricultural value than the types of the series with shallower surface soils.

The Norfolk fine sandy loam is not quite as good a soil as the Orangeburg fine sandy loam, but its more level topography compensates for the difference in productiveness. Corn and cotton, which form the exclusive crops, require heavy fertilization, and the type is much better adapted to vegetables and fruits.

The Norfolk sandy loam has about the same agricultural value as the Norfolk fine sandy loam. The drainage in some places is poor.

The Norfolk sand and coarse sand are other types of the series. They consist of sand deposits over 36 inches deep and are of little agricultural value when considered in the light of cotton and corn production, being unfertile and easily affected by drought.

The bottom land found along the streams is low and subject to frequent inundation. It is practically all heavily timbered. In the "prairie" section the Ocklocknee clay is the type occupying the bottoms, while in the sandy regions the Ocklocknee loam is the representative type.

SOIL SURVEY OF WINN PARISH, LOUISIANA.

By **THOMAS A. CAINE, H. L. BELDEN, and L. L. LEE.**

DESCRIPTION OF THE AREA.

Winn Parish is located in the longleaf pine hill section of northwest Louisiana, between the Red and Mississippi rivers. It is included within parallels $31^{\circ} 42' 32''$ and $32^{\circ} 8' 53''$ north latitude and meridians $92^{\circ} 18' 43''$ and $92^{\circ} 58' 23''$ west from Greenwich. It is bounded on the north by Bienville and Jackson parishes, on the east by Caldwell and Catahoula parishes, on the south by Grant Parish, and on the west by Natchitoches Parish. The thriving town of



FIG. 18.—Sketch map showing location of the Winn Parish area, Louisiana.

Winnfield, the parish seat, which has a population of over 4,000, is located about the geographic center of the parish. This town has become a railway center of considerable importance within the last few years. Geographically the parish lies in the Mississippi embayment, and the geological period represented is principally the Tertiary Eocene. There are 614,528 acres or about 960 square miles in the parish.

Most of the base map showing towns, roads, railways, streams, branches, houses, churches, and schoolhouses was constructed with the plane table by an experienced traverseman from the Geological Survey, as the soil mapping progressed. A small portion of the traverse around Winnfield, however, had been done by Prof. G. D. Harris, State Geologist of Louisiana, and his map was somewhat enlarged upon later by the U. S. Geological Survey in making a 15-minute quadrangle. The scale of the base map is 1 inch to 1 mile.

The area is well supplied with streams and branches. The Red River forms the boundary for a few miles in the southwest corner. The main drainage, however, passes through the Dugdemona River, which crosses the parish diagonally from the northwest to the southeast corner, dividing the area into about equal parts. Where this stream leaves the parish the altitude is about 50 feet above tide, while the highest point in the area is something over 300 feet, so that there is a range in elevation of about 250 feet. The area slopes gradually toward the southeast and all of the larger streams flow in the same direction and are more or less parallel to the Dugdemona and Red rivers. With the exception of the rather abrupt hills bordering the Red River and the Saline Bayou, the slopes bordering all the larger streams are gradual, and the streams themselves usually follow tortuous courses, through wide swamps, skirting which are often wide stretches of second bottoms (flat woods), the flood plains of former times. The ridges of lower elevation are usually broad and rather flat and in these the drainage is not yet well established; while those of higher elevation are hilly and often broken and the drainage and erosion are sometimes excessive. All of the drainage of the area eventually reaches the Gulf through the Red and Mississippi rivers.

In the colonial days of Louisiana the French made many settlements along the large water courses, and the territory comprised now in Winn Parish attracted a number of French families along the Red River and Saline Bayou. No permanent American settlements took place in the region until about the middle of the second quarter of the last century. Winn Parish was organized in 1852, and has since been greatly reduced in size by the organization of other parishes out of its territory.

Some of the early military and immigrant trails to Mexico and Texas crossed the parish, and these old overland routes were the scenes of great activity, and especially so when Texas was being colonized by Americans. The immigrants came mostly from Kentucky, Tennessee, Georgia, Alabama, and Mississippi; and in their westward journey across the country many were attracted by the good fishing and hunting and the excellent range and pasture for hogs and cattle in the numerous large swamps of what is now Winn Parish. Some

did not complete the trip to Texas, and some who did so came back to take advantage of the free and easy life of stock raising and fishing and hunting.

The present farming population of the parish is made up largely of the descendants of these immigrants, the early French families having given way entirely to Americans. About 5 per cent of the farming population of the parish is made up of negro property owners and tenants. There has been a great increase in population around the larger towns, owing to the lumbering interests and railroad construction. A large per cent of this increased population is made up of colored people, who came from widely separated sections, while the increased white population is made up mostly of people from Arkansas and Missouri.

Over the greater part of the parish the settlements are few and far between. Not more than 10 per cent of the land has ever been cleared and cultivated and the remainder is still covered either with virgin forests or slashings. The recent activity in lumbering and the high prices paid for timber lands have caused some to leave their farms to engage in day labor about the mills, and others to dispose of their entire holdings to the lumber companies. The result is that in many localities fields once cleared are growing up to brush and briers, and farmhouses once the homes of thrifty farmers are vacant and tumbling down. All of the public land has been taken up and has fallen largely into the hands of the larger lumber companies.

The crops are fenced and all stock turned at large. The roads are poorly kept and but few of the stream crossings are bridged. There is as yet no rural free delivery of mail. The telephone is just beginning to enter the homes of the most progressive farmers.

Winnfield, Dodson, Atlanta, Calvin, St. Maurice, Lofton, and Coldwater, all of which are located on railways, are the chief towns of the parish.

In the early days Trenton, Monroe, and Columbia, on the Ouachita River, and Montgomery and Alexandria, on the Red River, furnished the principal markets. Practically all who lived north of Dugdemona River swamp went to the points on the Ouachita, while those living south of the swamp went to the points on the Red River, the difficulties of crossing the Dugdemona swamp causing the division. Live stock were driven to market, and the cotton was hauled by oxen and often two weeks was consumed by the trip. In high-water time in winter the Dugdemona, Saline, and Castor streams permitted small boats to ascend into the parish, but very little of the farm products were marketed in this way, forest products forming the bulk of the traffic. During the dry season the Red and Ouachita rivers sometimes became so low as to stop navigation and the people were occasionally cut off from mail and supplies.

About a score of years ago, when the Vicksburg, Shreveport and Pacific Railway was extended westward from Monroe, Ruston became a popular market for a large part of the parish.

The year 1900 was the beginning of a new era for the agricultural interests of Winn Parish. In that year the Arkansas Southern Railroad was built from Ruston to Winnfield, being attracted thither largely by the increasing importance of the lumber interests. A short time afterwards the Louisiana and Arkansas was built from Sibley to Winnfield, and since that time Winnfield has continued to grow in importance as a railway center. The Louisiana and Arkansas Railway had been extended to Alexandria and a branch of it to Jena. The Winnfield branch of the Louisiana Railway and Navigation Company terminates at Winnfield and connects it with Alexandria and Shreveport. Winnfield is also the terminus of the Tremont and Gulf Railroad, which extends southward from Tremont, situated on the Vicksburg, Shreveport and Pacific Railway. The main line of the Louisiana Railway and Navigation Company passes through St. Maurice in the southwestern corner of the parish and the Iron Mountain Railway crosses the extreme southeastern corner of the parish and furnishes transportation facilities for that section. The new towns and numerous sawmill communities furnish a great demand for all kinds of farm and garden produce.

The farmers of Winn Parish being unaccustomed to the advantages of good markets and the benefits of modern railway transportation, have confined their efforts to the cultivation of their small clearings and have placed a large part of their dependence upon hogs and cattle, which are branded and run at large. It will take some time to adjust the agriculture to the changed conditions.

CLIMATE.

The climate of the area is temperate, the average annual temperature being about 65.5° F. The coldest weather occurs in December, January, and February, when the mercury seldom goes below the freezing point for more than two or three days at a time. Owing to the great humidity of the air, however, freezing weather is often felt with greater severity than farther north and west where the humidity is less.

Spring opens the latter part of March or the first part of April, during which months the fields are prepared and planted to cotton and corn. The average date of the last killing frost at this season is about March 24, but as the area sometimes lies in the path of the "northers," during the spring, truck and fruit and the tender cotton and corn plants are occasionally injured as late as the first week in April.

The summer months, June, July, and August, have an average temperature of about 82° F. After this the weather begins to cool gradually until the latter part of October, when light frosts may be expected. The average date of the first killing frost in the fall is about November 2, making the average length of the growing season about seven and one-fourth months. Thus it can be seen that the region has the long season necessary for the production of cotton and corn and other slow-maturing crops. The season is sufficiently long to permit of the growing and gathering of two crops of Irish potatoes, and many rotations can be followed that allow the harvesting of several crops on the same land in a single season.

The average annual precipitation is about 50 inches, and from November to the latter part of July the average rate of rainfall is 4½ inches per month. Occasionally there is a spring of excessive cold rains and this usually necessitates a great deal of replanting of cotton and corn. During August, September, and October the rainfall drops off to an average of about 2.9 inches per month, but as this is past the growing season no great amount of damage is done. The climate of the area is admirably adapted to the growing of small fruits, vegetables, and truck crops in general.

There being no Weather Bureau stations in Winn Parish, the following tables are compiled from records kept at Liberty Hill in the adjoining parish of Bienville. The figures are believed to be fairly representative of the local climatic conditions.

Normal monthly and annual temperature and precipitation at Liberty Hill, Bienville Parish.

Month.	Temperature.	Precipitation.	Month.	Temperature.	Precipitation.
	° F.	In.		° F.	In.
January.....	47.6	4.94	August.....	82.3	2.83
February.....	49.5	4.19	September.....	75.6	2.95
March.....	58.1	5.61	October.....	66.3	3.02
April.....	65.9	4.64	November.....	56.3	4.13
May.....	73.3	3.39	December.....	49.2	4.75
June.....	79.8	5.06	Year.....	65.5	50.38
July.....	82.4	4.87			

Occurrence of killing frosts at Liberty Hill, Bienville Parish.

Year.	Last in spring.	First in fall.	Year.	Last in spring.	First in fall.
1896.....	Apr. 7	Oct. 27	1904.....	Mar. 28	Nov. 11
1899.....	Mar. 29	Nov. 3	1906.....	Apr. 1	Oct. 29
1900.....	Apr. 1	Nov. 10	1907.....	Feb. 16	Oct. 14
1901.....	Apr. 3	Nov. 6	Average.....	Mar. 24	Nov. 2
1902.....	Mar. 6	Nov. 27			
1903.....	Mar. 25	Oct. 19			

AGRICULTURE.

The first settlers chose the region because of its special adaptation to stock raising. The numerous large swamps were forested principally with oaks and beech, and these furnished an inexhaustible mast for hogs. The swamps were also filled with dense canebrakes, and sometimes the cane extended out and covered the hills of lower elevation. This furnished excellent pasturage for cattle, and especially so during the winter months, when the wild grass pasturage on the hills was short.

The region was not settled rapidly because of its remoteness from navigable streams and the absence of railways, and for these reasons, largely, the conditions which existed over the greater portion of Winn Parish in 1900, when the first railway was constructed to Winnfield, were very similar to the conditions which existed there fifty years before.

The early settlers constructed for themselves log houses and barns, deadened a small patch of timber, and fenced in the whole. Each one strove only to produce enough corn, fruit, and vegetables to supply his family. The hogs were marked and the cattle branded and allowed to run at large in the swamps and woods. Later the stock was driven to market, and usually ten days or two weeks were consumed in the journey. Whatever surplus of farm products was produced was also hauled to market at Monroe or Alexandria in ox wagons. Outside of the Red River bottoms very little cotton has, until recently, ever been grown in the parish. Stock furnished practically the only source of revenue. Until about a decade ago the parish was so sparsely settled and so little value was placed upon the land that the settlers were not strongly attached to any one locality and frequently moved from one place to another. The importance of acquiring possession of the land and timber, either by homesteading or by direct purchase from the Government, did not impress itself upon them. The necessity of having to pay taxes caused many to have an aversion to acquiring legal possession, and until recent years there were many families who had lived in the parish for forty or fifty years and had never owned any land. The great difficulty of making clearings and the rapidity with which these clearings would grow up when once neglected or abandoned caused the people to regard the timber as an enemy. The great value of the pine and oak forests was not appreciated until the northern lumbermen appeared and began paying from \$1 to \$2 an acre for the land and timber. This was about twenty years ago, and since then there has been a steady increase in values, until some of the same land is now held at from \$25 to \$40 an acre. The timber lands have gradually fallen into the hands of the large companies, so that at present only about one-fourth of the lands and timber of the entire parish is owned by the original settlers or their de-

scendants. The great amount of labor employed on the railways and about the logging camps and sawmills has created an unsatisfied demand for all sorts of farm products, and the result of this has been to stimulate agriculture throughout the area. The most progressive farmers are striving to satisfy the local demands with vegetables, fruit, and meat. Stock raising, especially hog raising, has fallen off considerably, largely for the reason that with the destruction of the oak timber for staves the supply of mast has been greatly reduced.

Within the last few years considerable cotton has been grown in the hill section of the parish. The small portion of the area in the Red River bottoms has always been celebrated for its production of cotton. Practically all of the farmers in the hill section do their own work, while those on the Red River employ negro tenants. The general type of agriculture in practice at present is largely that in use in other hill sections of the State prior to the civil war. The people never were large slave owners, and were therefore accustomed to doing all of their own work. The principal products of the parish at present are cotton, corn, potatoes, vegetables, and forest products, the latter far exceeding in value all other products. The cotton crop is becoming greater each year, as the timber is being removed and more settlements are being made. The corn crop is secondary to cotton, and there is great room and need for expansion in growing this crop. The potato crop has not as yet assumed any great importance, but it bids fair to do so in the near future. The vegetables at present grown are principally those for home use.

It is generally recognized that the sandy upland soils are better adapted to cotton than to corn, while in case of the bottom-land soils the best yields of cotton are obtained upon the heavier soils. Cotton seems to thrive better upon heavy soils or upon those which have a heavy subsoil, while corn does best either upon the sandy bottom-land soils or the heavier upland soils. Sweet and Irish potatoes and all kinds of small vegetables thrive best upon the sandy upland soils. Sorghum and sugar cane do best upon the small branch bottom soils, while alfalfa thrives upon the heavy clay of the Red River bottom. The sandy gravelly ridges and hills of the highest elevation are the best for peaches, and in the early days a good grade of tobacco was grown upon them for home use.

There is practically no systematic rotation of crops practiced in the parish, cotton often following cotton until the yield decreases to a point where it is no longer profitable and the field then abandoned and allowed to grow up to brush and weeds. The acreage of corn is small compared with cotton, and the general type of farming may be considered a one-crop system.

Shallow plowing and shallow cultivation is the customary practice upon light and heavy soils alike, and all of the crops are culti-

vated in ridges regardless of location or kind of soil. No green manuring is done, and practically none of the barnyard manure is applied to the fields. In the winter time nothing is done to protect the bare fields from the damaging effects of leaching and erosion. The result is that both the upland and bottom soils are rapidly losing their original productiveness, and instead of building up and maintaining the fields already cleared, the farmers, in order to keep up their cotton production, usually bring new or fresh land under the plow every few years and allow the old fields to gully and wash and become reforested.

As before stated, practically all of the farms in the parish are operated by the owners, and the only exception to this is in the small strip of Red River bottoms, where the custom of letting the land out under the tenant system seems well established.

In recent years the tenant system practiced in the Red River bottoms has been more unsatisfactory than usual, owing to the ravages of the boll weevil and the fear of the colored people that they would not have anything for their year's work. The Red River planters, however, are remedying this by turning their attention to alfalfa growing.

The average size of the farms is about 150 acres; the holdings, however, range from a few acres to several thousand, and some of the larger timber concerns own as high as 50,000 acres.

The price of cleared and improved agricultural land varies with its location, the character of the soil, and the condition of the farm buildings. The average price, however, in the hill section ranges from \$5 to \$15 an acre. In the Red River bottoms the value of such land is much higher, the price ranging from \$25 to \$50 an acre, and some of the land can not be purchased at any figure. The timber land of the parish varies greatly in value, according to location and the amount of merchantable timber standing. The prices range from \$10 to \$40 an acre.

There is much to be said by way of suggestion for the improvement of the agriculture of the area. The things of most importance are rotation of crops, greater diversification of crops, thorough preparation of the soil, and the protection of the soil from the damaging effects of leaching and washing during the winter months. The rotation suggested as best suited to the conditions in Winn Parish is cotton one year, followed by corn and cowpeas, the latter to be sown at the last cultivation of the corn. Deep plowing (that is, to a depth of 7 or 8 inches) and a thorough preparation of the soil is half the cultivation. On the sandy types of good drainage, where so steep as to be subjected to serious erosion, the soil should be broken flat with a disk instead of being broken in high ridges. If the land is inclined to wash seriously this can often be stopped by terracing. If terracing is

not done such lands should be broken into high ridges encircling the hill. The close sticky soils like Houston clay, Susquehanna clay, Miller clay, and the Greenville loam should never be broken flat, but should be broken into high ridges. Another very desirable practice in connection with the thorough preparation of the soil is fall plowing, and the advantages of this are many. The air is allowed to penetrate the soil, and the alternate freezing and thawing of the soil have a tendency to loosen up the tight, stiff land, thus putting it in better tilth and insuring a better seed bed for the next crop. During the winter months much of the inert plant food is broken down, dissolved, and converted into a form available for plants the next season. Another desirable effect of deep, careful fall plowing is that it enables the soil to absorb and store up the winter rains, thus placing at the disposal of the plant roots for the next year a larger quantity of moisture, mitigating the effects of the droughty conditions which usually prevail in August and September. In order to get the best effects of fall plowing upon Houston clay, Susquehanna clay, Miller clay, and Greenville loam, these types should be tile drained, otherwise the soil will be inclined to run together and pack and thus increase its tendency to bake.

If care is not taken, the fall-plowed lands will wash badly during the winter months and the plant food rendered available by the processes mentioned above will be leached out by the abundant rains, which usually occur during January and February. In order to avoid these losses and the loss of fertilizers already in the soil the growing of winter cover crops like the rust-proof oat, crimson clover, wheat, hairy vetch, and the dwarf Essex rape is strongly recommended. On the light sandy soils the oat crop is the safest grain crop that can be grown, and if the ground is broken deeply in September sufficient moisture will be saved to insure a stand, and the oats will furnish an abundance of unsurpassed winter grazing for stock. The grazing of the oats during the winter, if the stand is good and they are on good land, does not injure them, but will actually improve the yield. Wheat sown upon good land furnishes a winter pasture nearly equal to oats. The yield of grain, however, is uncertain.

Crimson clover should be sown early if it is to furnish any winter grazing. It is best for grazing in the early spring. It is not advisable to cut it as a hay crop, because it is too woody; but it is a legume, and as a soil builder has great value. Crimson clover would do best upon such types as Houston clay, Susquehanna clay, Greenville loam, and Miller clay. The hairy vetch is also a legume, and is a very satisfactory winter cover crop upon the lighter types of soil. The land, however, must be well prepared and well manured.

All the winter cover crops more than pay for themselves in the excellent winter grazing which they furnish, and if the land is

wanted for cotton or corn before they mature the farmers can well afford to turn them into his soil in the green stage in February and thus get a profit in the vegetable matter added to his soil.

The recent appearance of the boll weevil in this section of Louisiana has caused the farmers a great deal of anxiety. It is believed, however, that the pest is proving to be a blessing in disguise, because the uncertainty of the cotton crop is inducing the progressive farmers to diversify more, and instead of growing all cotton and buying everything with cotton money they are beginning to plant more corn and grow more of the home necessities. A few of the most progressive farmers, however, are convinced that they can grow cotton in spite of the boll weevil, and they are basing their convictions upon what has been done in parts of Texas where the weevil has been for years. The successful plan for combating the weevil and the one advocated by Doctor Knapp and his agents in this section is briefly as follows: Grow the cotton as a surplus and not as the main money crop; prepare the soil thoroughly, and plant early. Growing cotton under boll-weevil conditions really resolves itself into a race between the farmer and the pest. The weevils do not appear in great numbers until July, and if the farmer can get his cotton sufficiently far advanced before that date he will be able to make a crop. In order to accomplish this the cotton should be planted in rows far apart, so as to insure an abundance of sunshine upon the entire plant, for shady, damp conditions are especially favorable for the weevil. In order to hasten the growth of the cotton plants frequent shallow cultivation is very essential, and in passing between the rows it is well to attach a short stick to each end of the whiffletree, so as to shake the cotton stalks as much as possible without injury. This knocks off the loose punctured bolls, as well as many of the weevils, a part of which perish in the hot sand. It is well to gather up the punctured bolls and burn them. All of this requires much labor and attention, but if cotton is grown as a surplus only, a few acres will be used where now many are cultivated, and it is safe to say that double the yields per acre can be obtained under this system.

SOILS.

The soils of the parish fall naturally into three divisions, namely, the upland soils, the second-bottom soils, and the soils of the Red River bottoms.

The upland soils consist largely of fine sandy loams, fine sands, and occasionally clays, and are derived mainly from the direct weathering of the underlying formations. These belong to the Lower Claiborne, Eocene, and consist of interstratified beds of fine sand, fine sandy clay, and clay, some of which are semiconsolidated. The beds are

everywhere nearly horizontal, and the character of the underlying material—especially the ease with which it erodes—seems to be the chief cause of the differences in topography. The erosion of the upland types is likely to be excessive.

The greater number of soil types encountered in the parish are found in the upland division. They belong, with two exceptions, in the following soil series: Norfolk, Orangeburg, Susquehanna, and Houston, all of which are common throughout the Atlantic coast and Gulf States, and have been mapped and classified in various other areas surveyed.

The second soil division is found associated with the uplands, but occurs as second bottoms bordering the swamps skirting some of the larger streams. It is represented by the single soil type Caddo fine sandy loam. Its surface is flat, and because of this fact, as well as the close, silty, clayey, impervious nature of the subsoil, the drainage is very poor. It is derived from the Port Hudson formation, and considerable areas of it have been found and mapped in the Caddo area, Louisiana.

The third division, comprising the Red River bottoms, is represented by a single soil series, the Miller series, of which two types are found, the Miller clay and the Miller fine sandy loam. The material from which these soils are derived is composed mostly of particles transported from the Permian Red Beds, on the headwaters of the Red River, more or less mixed with the sands, silts, and clays of more local origin. The clay contains considerable carbonate of lime, coming from a formation which is itself calcareous. The surface of the Red River bottoms is nearly flat, or at most of only gradual, slight slope away from the river banks toward the hills. The drainage near the base of the hills is poor, and at times of high water the crops there suffer most. The soil types here represented are alluvial in origin and are common throughout the Red River Valley.

Fifteen soil types were found in the area, the actual and relative extent of each being shown in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil	Acres.	Percent.
Norfolk fine sandy loam.....	191,424	31.1	Orangeburg fine sandy loam.....	5,440	0.9
Susquehanna fine sandy loam.....	163,584	26.6	Orangeburg sand.....	4,544	.7
Meadow.....	111,168	18.1	Miller clay.....	2,240	.4
Caddo fine sandy loam.....	49,408	8.1	Greenville loam.....	2,048	.3
Susquehanna clay.....	38,272	6.2	Houston clay.....	1,728	.3
Orangeburg fine sand.....	27,072	4.4	Norfolk sand.....	704	.1
Greenville gravelly sandy loam.....	10,752	1.8	Miller fine sandy loam.....	640	.1
Norfolk fine sand.....	5,504	.9	Total.....	614,528	.....

MILLER CLAY.

The Miller clay consists of about 8 inches of brownish-red or chocolate-colored silty clay, underlain to a depth of 3 feet or more by a stiff, tenacious, heavy, plastic red clay. When first broken it is a very difficult soil to turn with the plow, but if care is taken to plow deep and when the proper moisture condition exists, it becomes mellow and rather friable, especially if coarse manure, straw, or pea vines are turned under for a year or so.

This type of soil is confined to that portion of the area bordering the Red River and extending for a few miles up Saline Bayou, which is a large tributary of that river and subject to backwater during high floods. The soil is alluvial in origin, the material having been eroded from the Permian Red Beds along the headwaters of Red River and carried down in suspension and spread out over the flood plain of the river during periods of overflow. The coarser material thus carried down was often deposited near banks of the river and resulted in building up a low sandy ridge, while farther back from the main channel of the river, where the current of the flood waters was sluggish, the finer material, like silt and clay, was deposited. These fine silty and clayey deposits constitute the type Miller clay in the present area.

Lying about 40 feet above low water in the Red River this type is seldom subject to overflow, though it is somewhat lower than the narrow sandy ridge which is often found on the immediate banks of the river. Next to the base of the upland hills the natural drainage conditions are such as to give rise to small stretches of swamps and brakes. The drainage from the uplands, instead of taking a straight course toward the river, is usually diverted and runs parallel to it, passing from one small swampy area to another, until finally it cuts through the sandy ridge and enters the river. The greater part of the Miller clay has been cleared, drained, and placed in cultivation, and the unreclaimed portion could easily be cleared and drained if economic conditions justified it. The original forest was a heavy growth of hardwoods—oaks, gum, and considerable cypress—with a dense undergrowth of vines, briars, and small shrubs.

Unusually well adapted to cotton and corn, it is used mainly in the production of these crops, the former averaging about 1 bale per acre and the latter ranging from 25 to 35 bushels per acre under ordinary conditions and without special care or attention. The type is usually farmed in large plantations, and for many years cotton and corn have been the only crops grown. There has been no system of rotation, except cotton one year and corn the next, and the soil is naturally so productive that the need of commercial fertilizer or the growing of cowpeas or other legumes has never been

seriously felt. Owing to the flat, level surface of the fields and the stiff, clayey nature of the soil and subsoil, it is always late in the spring before cotton can be planted and equally late in the year before the crop can be gathered. Lateness of planting is a condition especially favoring the ravages of the boll weevil, and as a result the plantations upon this soil have suffered more from that pest than upon any other type in the area. The labor has become demoralized, and large plantations are growing up to grass, weeds, and briers, while the value of land has dropped to nearly half what it was a few years ago. Noting the success of farmers in other parts of the Red River Valley in growing alfalfa, some of the farmers in this area are now turning attention to that crop. Where the drainage conditions are naturally fair or have been made so by artificial means, very satisfactory results have been attained, but where the conditions are such that water collects and stands after a rain the crop has been an absolute failure. The farmers are learning that the greatest care and attention in the matter of drainage is necessary if a success is to be made with this crop. Under the best and most favorable conditions the crop has been cut from three to four times during the season, with an aggregate yield of about 4 tons per acre. Owing to the dampness of the climate and the frequency of showers considerable difficulty is being experienced in curing the crops. It is believed, however, that this is a condition which could be largely overcome by making use of hay caps. There is usually a great demand for alfalfa hay, and the farmers find no trouble in disposing of the crop at prices ranging anywhere from \$12 to \$20 a ton. Some farmers in the Red River Valley have found that by proper management the profits from growing alfalfa upon the Miller clay are sufficiently large to enable a person to buy the land on credit and pay for it in from two to five years. Either Bermuda grass or Japan clover does very well under conditions favorable for alfalfa, but an equal mixture of Japan clover and Bermuda grass seems to be more popular than either separately. The average yield for the season is about $2\frac{1}{2}$ tons per acre. A few farmers are turning their attention to hog raising, and thus in a measure avoiding too great dependence upon cotton. They are considering the possibilities of raising the hogs upon alfalfa pasture and producing enough corn to fatten them before killing. It is believed that there are great possibilities in this direction.

Only 2,240 acres, or about one-half of 1 per cent of the area, is occupied by this type, but at one time nearly as much cotton was produced upon it as upon all other soil types in the parish. This, however, was largely due to the fact that the first settlements in the region took place along the Red River, while a large part of the balance of the parish is still in virgin pine forests.

Prior to 1865 the soil was all in large plantations, but in recent years many of these have changed hands and been divided into smaller holdings. Some of the present owners still hold large tracts, and the usual method of farming them is to parcel out small areas to negro tenants. Under this system the preparation of the soil and the handling of the crop is usually careless and wasteful, unless the closest supervision is maintained. The plowing is very shallow, and this with clean cultivated crops year after year has so reduced the organic content of the soil as to increase greatly its natural tendency to puddle in wet weather and to bake and crack in dry weather. It is recommended that in the preparation of the ground the soil be plowed deeper and that a regular system of rotation be established in which cowpeas should find a place. It is also recommended that the peas be sown between the corn rows during the summer. The roots will loosen up the soil and subsoil and lessen the tendency to puddle and bake, besides making the fields productive through the addition of organic matter and nitrogen.

The following table gives the results of mechanical analyses of the soil and subsoil of the Miller clay:

Mechanical analyses of Miller clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18177.....	Soil.....	0.2	0.5	0.7	5.0	21.2	57.7	14.9
18178.....	Subsoil.....	.0	.2	.4	8.6	21.5	32.6	36.9

MILLER FINE SANDY LOAM.

The soil of the Miller fine sandy loam is light brown in color and ranges in texture from a fine sand to a fine sandy loam. Its depth varies from 8 to 20 inches, with an average of about 15 inches. The subsoil to a depth of 36 inches consists of reddish-colored silty fine sandy loam. The type in general possesses a loose, open texture, which allows the ready percolation of water, and it is an easy soil to plow and cultivate.

Though of alluvial origin, it at present is seldom subject to overflow, being about 40 feet above low water. It occurs as a natural levee near the banks of the Red River and the lower course of Saline Bayou. Its width varies from a few rods to about one-fourth mile. It slopes both toward the Red River and inland toward the area of Miller clay, and this, together with the slight irregularities of surface and loose, open texture of the soil, insures excellent drainage. The original source of the material is the same as that of the Miller

clay, viz, the Permian Red Beds, the chief difference lying in the larger size of the particles, which has caused a quicker deposition on slackening of the stream currents, and resulted in building up areas of the type upon the immediate banks of the river.

The Miller fine sandy loam is very well adapted to cotton, corn, and all sorts of garden truck, like strawberries, radishes, onions, cabbage, collards, turnips, and watermelons. Cotton and corn are practically the only crops grown at present. Where the boll weevil is active this soil is considered much more desirable for cotton than the Miller clay, for the reason that it is an early soil and the cotton has a chance to get well toward maturity before the weevil appears in destructive numbers. Ordinarily it produces larger cotton plants than does the Miller clay, but usually they do not fruit as well as on the latter. In ordinary years cotton yields about 1 bale per acre. It is considered slightly better adapted to corn than is the Miller clay, and the maximum yield is about 40 bushels per acre, with an average of about 30 bushels. On the other hand, it is not considered as desirable for alfalfa, Bermuda grass, or Japan clover as is the Miller clay.

The method and practices with regard to plowing, planting, cultivation, and rotation are practically the same as upon the clay adjoining—either cotton one year and corn the next or cotton for two or three years in succession. Shallow plowing and cultivation are generally practiced, but it is seldom that the crops suffer from droughts. Considerable difficulty, however, is experienced with vines and weeds, and in order to clear the land of these an occasional deep plowing is recommended. It is also suggested that enough fruit and vegetables be grown upon this type to supply the home and local market demands.

The Miller fine sandy loam is practically all under cultivation. The value ranges from \$25 to \$40 an acre. It is an important type in the Red River Valley, but occurs in such small areas in Winn Parish as to have little influence upon the agricultural conditions and values of land in the area as a whole.

The following table gives the results of mechanical analyses of the soil and subsoil of the Miller fine sandy loam:

Mechanical analyses of Miller fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18181.....	Soil.....	0.0	0.2	0.2	19.2	32.3	43.7	5.3
18182.....	Subsoil.....	.0	.3	.9	32.6	28.4	32.2	4.9

SUSQUEHANNA CLAY.

The soil of the Susquehanna clay consists of a brownish-red or red clay loam with a depth of about 4 inches, the first 2 inches being darker in color, owing to an accumulation of organic matter—the decayed remains of leaves and grass. The subsoil is a stiff, tenacious, plastic red clay to depths varying from about 20 inches to 3 feet, below which it usually becomes mottled with drab and gray. The proportion of the gray and drab colors increases, until at a depth of 5 or 6 feet the red color often disappears.

Because of the abundance of easily tillable sandy soils in the region, and the great difficulty of plowing and cultivating the Susquehanna clay, it is held in low esteem and practically none of it has ever been put in cultivation. It occurs in rather large areas southwest of Calvin and also in the region west of Tannehill and Dodson. Another area, though not as typically developed, occurs east of Packton. It is also found in small, isolated patches in other parts of the parish.

In topography the Susquehanna clay varies from nearly level to rolling, and in places artificial drainage would be necessary if the land were placed in cultivation. It is a residual soil derived principally from the Lower Claiborne formation. There are in some places a good many clayey iron concretions strewn upon the surface and in others some broken fragments of fossiliferous clay ironstone were observed.

The type is often spoken of as "hog wallow" or "post-oak flats." Scrubby post oak, black-jack oak, some shortleaf pine and "hog" haw are the characteristic trees upon it. A few farmers have at different times brought small patches of this soil under cultivation where it adjoins or is a part of fields made up of other types of soil, and no one was found who did not believe that the type is naturally a very productive one, if it can be handled properly. It is not likely that the Susquehanna clay will be cultivated to any great extent in the near future, but if the region eventually becomes thickly settled and land becomes much higher in price it is believed that this type will become more popular and its value will be more fully recognized.

In cultivating the soil both surface and tile drainage will be necessary to get the best results, and an abundance of organic matter, like coarse manure and pea vines, if turned under, will do much to mellow the soil and lessen its tendency to bake and crack in dry weather. It is believed that it would make excellent land for the production of native hay, and if pastured only when in proper condition would be excellent for pasture grasses. Oats are said to do very well upon soil of this character.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Susquehanna clay:

Mechanical analyses of Susquehanna clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18215, 18217.....	Soil.....	1.7	2.5	1.4	8.1	25.5	37.1	23.6
18216, 18218.....	Subsoil.....	1.3	1.3	.6	4.0	17.7	27.2	47.4

SUSQUEHANNA FINE SANDY LOAM.

The soil of the Susquehanna fine sandy loam ranges from a fine to medium, loose-textured gray sandy loam to a gray loamy fine sand. In depth it varies from 6 to 18 inches, the average being about 12 inches. Sometimes there are numerous iron concretions and fragments of iron crusts strewn upon the surface of the hills. The subsoil is usually rather impervious, and in the virgin state the arrangement of the overlying soil materials is interesting. The finest materials, like silt and very fine sand, will be found immediately overlying the subsoil, while above will come the coarser grades of sand. In fields that have been cultivated for several years this arrangement of soil materials is broken up, the surface soil has become homogeneous, and the line of demarcation between the soil and subsoil is sharp and distinct.

The subsoil of this type is composed of a very plastic, tenacious, red or mottled red and gray clay. Very frequently the subsoil is a heavy, plastic, tenacious red clay to a depth of 30 inches, below which the clay becomes mottled with gray or drab and the deeper one goes below 30 inches the more pronounced the gray color becomes, until at a depth of 4 or 5 feet the subsoil is usually sandier and much lighter colored. Indeed, there is almost always an appreciable quantity of very fine sand and silt in the subsoil, though the heavy plastic nature of the material as a whole gives it an impervious character. Except in eroded spots on the hills, where the subsoil is exposed, the type is a very easy one to plow and cultivate. In newly cleared fields the soil is darker colored and more loamy than is usual after a year or so of cultivation, when these characteristics gradually disappear and the soil assumes a closer structure and is not readily kept in good tilth unless means have been taken to maintain the content of organic matter.

In all of the more elevated portions of the area the Susquehanna fine sandy loam is found, and it is especially well developed in the region south and west of Winnfield. It is of wide extent in the large drainage basins and along the divides between these where the conditions have resulted in active weathering and erosion. Its surface is

rolling to hilly, and often it is badly dissected and irregular, this being especially the case along the upper reaches of the small streams. The drainage is inclined to be excessive, and owing to the usual rough topography great care is necessary in order to keep the sand from washing off the surface of the cultivated fields and exposing the subsoil. Owing to the plastic, impervious nature of the subsoil and the usual sandy, loose nature of the soil, the water-holding capacity of the type is not great, and for this reason much of the rain water is not absorbed, but runs off over its surface. This causes excessive erosion and accounts for the usual rough, irregular surface of the type as a whole.

The Susquehanna fine sandy loam owes its origin to the weathering of the sands and clays of the Claiborne Eocene formation. Less than 1 per cent of the type is in cultivation, and it is still covered with its original forest growth of post oak, black-jack oak, shortleaf pine, and dogwood. It is characterized by numerous post-oak and black-jack oak thickets. When it lies well and is carefully prepared and cultivated, it is a good soil for all of the general farm crops of the region. Cotton and corn are the principal products, and it is considered a little better for these crops than is the Norfolk fine sandy loam, for the reason that it can be built up and the effects of fertilization are much more lasting than upon the latter type. When the land is "fresh"—that is, just cleared—and contains an abundance of humus and organic matter, it produces from two-thirds to three-fourths bale of cotton and from 25 to 35 bushels of corn per acre, but after three or four years of continuous cropping the yields usually fall to about one-third bale of cotton and 12 bushels of corn per acre. This soil is also well adapted to truck crops, and where the sand is over 5 inches deep it is believed that certain grades of bright tobacco and also peaches could be successfully produced.

Shallow plowing and ridge cultivation are practiced on this type as on the other soils of the parish. Deeper plowing is particularly to be desired in this case, as loosening up the impervious subsoil will increase the water-holding capacity of the soil and thereby lessen the tendency to wash. For the same reason a system of rotation in which cowpeas or some other leguminous crop is included should be followed. The type is an excellent one for oats, and the following rotation is suggested: Cotton one year, corn the following year, and oats the third year. Sow cowpeas at the last cultivation of the corn and in the third year sow cowpeas as soon as the oats are harvested. Always plow deep, and this, together with the above rotation, will not only maintain the original productiveness, but tend to prevent washing of the soil. About 27 per cent of the area—163,584 acres—is occupied by this soil, so that it has a great influence upon the agricultural conditions in the area. A large percentage of the soil is held

by outside lumber interests and sells with the timber at \$15 to \$25 an acre. Cleared land for farming purposes ranges from \$5 to \$15 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Susquahanna fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18221, 18223.....	Soil.....	0.1	0.6	0.6	29.1	30.4	32.9	6.3
18222, 18224.....	Subsoil.....	.0	.2	.3	10.5	32.8	27.9	28.1

NORFOLK FINE SAND.

The soil of the Norfolk fine sand consists of about 8 inches of gray to light-brown loamy fine sand. There is usually no distinct line of demarcation either in color or texture between the soil and the subsoil, but the one grades into the other and changes by imperceptible degrees with increasing depth, until at 24 to 36 inches the material consists of a light-brown or reddish-brown sticky fine sandy loam. The reddish color of the subsoil is more pronounced on the crests of slight elevations, the color in leveler areas being lighter. Where this soil grades into the flat woods and swamp lands the subsoil is often slightly mottled with drab.

This alluvial soil is found associated with the larger streams in all parts of the parish, and is locally known as "hammock" land. Sometimes it is found as a small islandlike elevation, surrounded on all sides by swamp. In such instances it is called "first hammock." Again it may be associated with the second bottoms, or what is locally called "flat woods," and in such cases it is called "second hammock." Slight elevations in the low-lying leveler areas of Norfolk fine sandy loam often have many of the characteristics of "hammock" land and are often designated by the people as "third hammocks." Of these three different kinds of "hammock" land, the first is the one which occurs in the largest areas, is held in highest esteem by the farmers, and is representative of the type. The subsoil of the "second hammock" land is inclined to be somewhat lighter colored, more "crawfishy" and more "seepy" than the typical soil. As a whole it is an easy soil to plow and cultivate, and may usually be prepared and planted earlier than the Norfolk fine sandy loam. It was among the first soils to be cleared and put under cultivation.

In surface features it varies from nearly level to rolling, and owing to this and the porous structure of both soil and subsoil its drainage is naturally good. It is seldom if ever subject to overflow, but some-

times is cut off from the main land by inundation of the surrounding swamps.

In the early days these areas were sought out and cleared, because they were considered desirable for home sites and because of their convenience to the large hog and cattle ranges in the near-by swamps. The soil is naturally a productive one, and well adapted to cotton, corn, fruit, and vegetables. It is used exclusively for cotton and corn, and in growing these crops no definite system of rotation is practiced. The average yield for cotton is one-half bale, while that for corn is about 20 bushels per acre. Much larger yields are possible, but the soil has been cultivated continuously for so long that its productiveness is reduced at least one-third. The same rotation is recommended for this soil as for Norfolk fine sandy loam. It is believed that the soil would be an excellent one for peaches, strawberries, and watermelons, besides all kinds of light truck. Owing to the limited area occupied by this type it has no great influence upon the agricultural condition or upon the general value of land in the parish.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Norfolk fine sand:

Mechanical analyses of Norfolk fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18185, 18189.....	Soil.....	0.2	0.9	0.4	34.9	16.4	40.4	6.4
18186, 18190.....	Subsoil.....	.0	.2	.2	25.9	19.1	39.1	15.5

CADDO FINE SANDY LOAM.

The surface soil of the Caddo fine sandy loam to an average depth of about 12 or 15 inches consists of an ash-gray or drab-brown, compact, very fine sandy loam, containing so high a per cent of silt that it is frequently difficult to determine from a field examination whether it is a very fine sandy loam or a silt loam. Occasionally the texture of the surface material is uniform to a depth of 20 inches. The subsoil consists of a gray, sometimes chalky, compact, impervious material, which varies in texture from a silty very fine sand to a silty clay. Below this, at depths ranging from 18 to 36 inches, the material increases in the content of silt and clay, and the usual ash-gray color becomes mottled with streaks of drab, yellow, and sometimes of brown and red, and in these lower depths iron concretions are sometimes present.

None of the Caddo fine sandy loam is in cultivation, but as far as the texture of the soil is concerned it would be an easy one to plow and cultivate. It is found in all of the larger stream valleys of the

area. It is not an alluvial soil, however, but is probably derived from the Port Hudson, and therefore deposited in Quaternary times when these old valleys were submerged. The only original difference between this type and the unassorted material of the Norfolk fine sandy loam, which lies at a higher elevation, is that caused by the assorting power of water. The difference in elevation and the effects of weathering, erosion, and rain wash have since made the difference between these two types more pronounced.

The surface features of the Caddo fine sandy loam vary from flat to mounded and gently rolling. Upon the one side it merges gradually into the swamp areas, while toward the uplands it gradually gives place to the more rolling areas of Norfolk fine sandy loam. Its elevation above the swamp lands varies from a few feet to about 25 feet, but it is never subject to overflow from the swamps. The hummocky areas are composed of numerous mounds seldom 50 feet across and never more than 3 or 4 feet high. The material on the mounds is somewhat sandier than the intermound spaces.

The soil is naturally poorly drained because of its generally flat surface, lack of established drainage ways, and the impervious character of the subsoil. During the wet season water usually stands on the surface for weeks at a time, and finally disappears mainly through gradual seepage into the swamp areas and through evaporation. The surface material sometimes becomes so thoroughly saturated with water to a depth of 20 inches that it becomes boggy and an auger can readily be pushed through it to that depth. Upon boring below 20 inches, however, and sometimes less it will be found that the subsoil is so dry and compact that it is exceedingly difficult to turn the auger in it, notwithstanding the fact that the surface above is covered with water. This soil is similar to the Hammond silt loam which occurs in large areas in Tangipahoa Parish and upon which, by proper drainage and the heavy application of fertilizers, the strawberry industry has proven to be very profitable. In handling this soil thorough surface drainage is absolutely necessary in order to remove the standing water. There is always sufficient fall toward the swamp areas to insure good drainage through open ditches and canals. It is believed, too, that the type is well suited to the production of rice if some means could be devised to furnish water for the necessary flooding, and there are apparently many locations where the necessary water could be obtained, either by pumping from near-by streams or by diverting the water from these streams a few miles above and leading it through canals to the fields.

At present the Caddo fine sandy loam is wholly in forest. The mounded phase constitutes a very small proportion of the whole, and in such places the timber is made up of longleaf and shortleaf pine. The usual timber growth, however, is pin oak, white oak, post oak,

black oak, and shortleaf and loblolly pine. The soil is locally known as "flat woods" and "pin-oak flats."

It is not probable, even when cleared, that this soil will be well adapted to the general farm crops of the region, but it may be made excellent permanent pasture land, and also has good possibilities for special crops like strawberries, rice, and probably sugar cane.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Caddo fine sandy loam:

Mechanical analyses of Caddo fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18157, 18159.....	Soil.....	0.2	0.4	0.2	19.3	27.4	47.9	6.1
18158, 18160.....	Subsoil.....	.1	.3	.2	16.5	27.3	44.3	11.4

HOUSTON CLAY.

The soil of the Houston clay is a brown to black clay ranging in depth from 4 to 8 inches. The subsoil to a depth of 3 feet or more consists of a greenish-yellow clay, usually containing many white chalky lime concretions about the size of a pea. Scattered upon the surface and disseminated throughout the soil and subsoil are found fragments of impure fossiliferous white limestone, varying from 2 to 6 inches in diameter. These, however, are never numerous enough to interfere with cultivation.

In the small patches between St. Maurice and Calvin the Houston clay is especially well developed. It is also found west of Dodson, on Antwine and Big creeks. It is in these localities that the fragments of fossiliferous limestone occur, and the fossil evidence seems to indicate clearly that they are Lower Claiborne in age. In the region near Prairie Home there is another area of the type, but in this no limestone rocks occur. There is, however, considerable gypsum in the form of crystals. According to Harris the Houston clay in this vicinity is probably of Eocene age, but derived from the Jackson formation. The soil seems to be always associated with areas of Susquehanna clay.

The surface of the Houston clay is usually level to rolling. Along Antwine and Big creeks it occurs in depressed areas just above the overflow land of these streams, and in order to get the best results from it the farmers have found it necessary to construct open ditches to carry off the water from the adjoining hills. Ordinarily, however, it is rolling enough to insure good surface drainage.

In origin the Houston clay is residual, being derived from the weathering of the underlying unconsolidated layers of marls and

chalky clays of Eocene age and of either the Lower Claiborne or the Jackson formation. The lime rock found in the type represents hard, resistant portions of the underlying material. Heretofore this type has usually been associated with the Cretaceous limestones and has occurred especially well developed in the black land belt of Texas. Its occurrence in the basal horizons of the Tertiary is accounted for by the fact that in the earlier Tertiary there were doubtless places where the conditions were similar to those existing in the Cretaceous and these brought about similar depositions. Portions of the type have never been forested and are known as prairie. Other areas originally had a mixed growth of white oak, red oak, some hickory, shortleaf pine, and several varieties of thorny shrubs.

Owing to the great abundance of easily worked sandy land in the parish, the small isolated patches of this soil, the difficulty of plowing, and its tendency to wash badly it is not held in high esteem for farming land. The farmers are accustomed to plow with one horse, and since it is impossible to break this soil satisfactorily unless two or more heavy horses are used, it has never been in great favor. A few, however, recognized its value in growing cotton, corn, and also hay crops. The average yield for cotton is about 1 bale per acre, but the yields range anywhere from three-fourths bale to 1½ bales. The yield of corn is from 35 to 60 bushels per acre, with an average of about 40 bushels. Bermuda grass, crab grass, and Japan clover are the only hay and pasture crops grown thus far. It is believed that where the drainage conditions are satisfactory alfalfa would be more satisfactory and more profitable than any of these.

Commercial fertilizers apparently do not produce any marked increase in crop yields, but decidedly beneficial results have been obtained from growing cowpeas, which seem to loosen up the soil, make it more productive, and less liable to severe washing.

One of the most serious difficulties in cultivating the Houston clay is to prevent erosion, especially in areas that are rolling or slightly hilly. Clean cultivation year after year, without the addition of coarse material like barnyard manure or pea vines, is largely responsible for its tendency to wash, and the application of manure and growing of cowpeas or some other legume are strongly recommended. Deep plowing and frequent cultivation will also assist the soil in absorbing the rainfall and to this extent reduce the run-off.

Because of its limited extent the Houston clay has little agricultural value. In bodies of 25 to 100 acres this type would sell for about \$35 an acre.

The following table gives the results of mechanical analyses of this type of soil:

Mechanical analyses of Houston clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18171.....	Soil.....	1.6	2.6	1.4	4.0	5.6	54.2	29.6
18172.....	Subsoil.....	.7	1.0	2.6	10.6	12.0	42.9	29.9

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 18172, 35.09 per cent.

NORFOLK FINE SANDY LOAM.

The soil of the Norfolk fine sandy loam, to a depth of 8 or 10 inches, is a gray or brownish-gray fine sandy loam or a loamy fine sand of the same color. In areas which have never been in cultivation the soil grades imperceptibly into a subsoil of yellowish color, the texture of which usually becomes a sandy clay at a depth of about 30 inches. In cultivated fields the color difference between the soil and subsoil is usually quite distinct. The usual color of the subsoil is yellow, but in many cases on the crests of slight elevations where the drainage conditions are unusually perfect it is slightly reddish yellow or chocolate yellow. In such locations, too, the texture of the subsoil is inclined to be somewhat more clayey. In depressions and flat, poorly drained spots the color of the subsoil below 30 inches is usually yellow mottled with drab, and here the texture of the subsoil is often slightly more sandy than the typical subsoil.

The Norfolk fine sandy loam is easy to plow and cultivate, both because of its texture and gentle topography, but owing to its usual location upon the lower slopes and the low, gently rolling divides it does not drain as readily as some of the other types in the parish, and consequently crops can not usually be planted as soon. This condition, however, is one easily remedied by artificial drainage. The water-holding capacity of the soil is rather above the average, and in a droughty season crops suffer much less upon this than upon the higher lying, sandier soils.

The Norfolk fine sandy loam is derived largely from the Lafayette formation—a mantle of sandy material deposited upon the older Eocene sediments when the region was depressed below the level of the Gulf. In some localities, however, it seems to owe its origin to the direct weathering of the sandy layers of Eocene age.

About 299 square miles, or 31.1 per cent of the parish, is composed of the Norfolk fine sandy loam, so that in point of area it is an important type. However, a very small proportion of it is in cultivation, the remainder being virgin forest. The growth is composed mostly of shortleaf and loblolly pine, with a sprinkling sometimes of

longleaf pine, maple, and white oak. In the "gladey" places a few black gum trees are found.

Small patches of the more rolling, better-drained portions of the type are in cultivation. On these cotton, corn, and sugar cane are practically the only crops. It is not a strong soil, but for two or three years after clearing it will produce on the average about two-thirds bale of cotton and 20 bushels of corn per acre. After the virgin humus is exhausted the crop yields decrease rapidly, unless manures are applied and a proper crop rotation is followed. Under the present conditions of farming cotton yields from one-fifth to two-thirds bale per acre, with an average of about one-half bale per acre, and corn from 8 to 20 bushels, with an average of about 12 bushels per acre. The soil is well adapted to growing sugar cane, but as yet it has been produced only for home use, with yields ranging from about 150 to 250 gallons of sirup per acre.

As already intimated, the soil needs constant care and attention in order to maintain its productiveness. Applications of fertilizers, either commercial or home products, are not very lasting, and in order to get the best results it is necessary to make applications every year. The most satisfactory results have been obtained by the few who make a practice of sowing cowpeas upon the land as frequently as possible. It is believed that the farmers would do well to adopt the following rotation: Sow oats and after the harvest sow cowpeas, plow the ground during winter months and plant to cotton the following spring. The next year plant corn and put the rows far enough apart so as to permit sowing a row of cowpeas in the middle. By this scheme of rotation, or by some similar plan, it is believed the productiveness of the type could be maintained.

When the region develops and market conditions improve this type of soil will have great possibilities in the production of truck.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Norfolk fine sandy loam:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18191, 18193.....	Soil.....	0.3	0.6	3.2	19.4	38.8	30.9	6.6
18192, 18194.....	Subsoil.....	.1	.4	2.8	16.1	35.6	24.7	19.8

NORFOLK SAND.

The material composing the Norfolk sand is made up of gray and white incoherent sand of prevailing medium texture to a depth of 36 inches. In the lower depths of the material there is a tendency

toward a yellowish color and this is more pronounced in the areas that occur adjacent to Saline Bayou. Where the soil occurs on the hills, however, the color of the subsoil is yellowish at 36 inches, but becomes reddish below that point.

The Norfolk sand occurs principally in the western part of the parish, along Saline swamp and upon the rolling hilltops a mile or so back from that swamp. Owing to its loose, open texture it is easy to till. In surface features it varies from nearly level to gently rolling upon the lowland areas lying in the Saline bottoms to hilly and rolling in the upland areas. The drainage is inclined to be excessive in the uplands, and crops are apt to suffer severely during dry weather. In the lowland, where the water table comes close to the surface, crops are affected little by ordinary periods of drought.

Because of the unfavorable moisture conditions prevailing over much of its areas, very little of this type is under cultivation at present. Only a few patches here and there along Saline swamp have been cropped. The soil is not naturally a very productive one, and the effects of fertilizers are not lasting. Cotton and corn are at present the only crops, the yield of the former being about one-third bale per acre, and of the latter about 15 bushels per acre. Crops can be planted upon this soil earlier than upon any other type in the area, and now that the early planting of cotton has become so necessary in combating the boll weevil, it is suggested that more of this soil could well be used in cotton production. By following a system of rotation designed to add organic matter to the soil (and this can best be done by including some of the legumes, preferably cowpeas) much larger yields of both cotton and corn are possible. The soil is very well adapted to the growing of all kinds of early light-truck crops as well as Irish potatoes, watermelons, and peaches.

Only a little more than 1 square mile of the soil occurs in the parish, but under the present conditions with respect to the boll weevil and the increasing demands of the near-by logging camps and saw-mills for fruit and vegetables, to which the soil is especially well adapted, it is destined to become an important factor in the agriculture of the western part of the parish.

MEADOW.

The Meadow includes that portion of the stream valleys subject to such frequent overflow as to render it unfit for farm crops of any kind at present. The material composing these bottoms is often quite variable in short distances, but is generally made up of a silty loam or a silty fine sandy loam.

The areas are found along all of the larger streams of the parish, but are especially conspicuous on Dugdemonia and Saline swamps,

where areas varying from 1 to 2 miles in width were mapped. Under the present conditions such land has no value from an agricultural standpoint, except for the abundance of winter pasturage it affords. The Meadow has considerable value for its timber, which consists principally of white oak, red oak, pin oak, cypress, loblolly pine, red and white gum, hickory, ash, and beech.

GREENVILLE GRAVELLY SANDY LOAM.

The soil of the Greenville gravelly sandy loam varies from a gray fine sandy loam to a reddish fine sandy loam, and has an average depth of about 10 inches. The subsoil to a depth of 36 inches, and often to 4 or 5 feet, consists of a bright-red sandy gravelly clay, but, as shown in the road cuts, the material at a depth below 36 inches sometimes becomes mottled with yellow and drab. The gravel in the subsoil consists of ferruginous iron concretions, and these and fragments of iron sandstone are usually present in the soil and scattered upon the surface. On the hilltops, where the finer particles of sand have been washed off, the surface is often thickly strewn with this coarse material, the fragments varying from one-half inch to 6 inches in diameter, and the type is known locally as "red sandy gravelly land."

The Greenville gravelly sandy loam is an easy soil to plow and cultivate, and usually the fields are free of stumps, indicating that the type has been in cultivation a long time. Shortleaf pine and oaks were the characteristic native vegetation.

This soil is not of wide occurrence in Winn Parish, and is typically developed only in the northwestern part, in the vicinity of Gansville. To the northward, in the adjoining parishes, it becomes an extensive soil type and one which has contributed largely to the wealth of northwestern Louisiana and southern Arkansas.

The usual topography of the soil is rolling to hilly, and owing to this and to the somewhat open nature of the subsoil the drainage is naturally good. The type has been derived from the weathering of sands and sandy clays of the Lower Claiborne formation, and the few rock fragments found upon the surface have been formed from the hardening of the sandy layers and are not the fragments of indurated rock formations. The soil is characterized by its high content of iron, the presence of large quantities of iron concretions and iron crusts being evidence of this. The iron occurs as brown hematite and limonite ores, but not in sufficient quantities to be of economic value.

The Greenville gravelly sandy loam is moderately productive of all the general farm crops of the region, and besides is especially well adapted to peaches, small fruits, vegetables, and truck crops. In the early days a fine grade of tobacco is said to have been produced for

home use, but at present none is grown. The average yield of corn is about 20 bushels, and of cotton one-half bale per acre. With careful cultivation much better yields of both are possible. At present not many peaches are grown, but the quality of those produced and their good size and fine color indicate that the peach industry would prove very successful and profitable. It is likewise probable that tobacco growing could be made a paying industry.

Owing to the desirability of this type for general farming, it is nearly all cleared and under cultivation and well improved. For these reasons, although it is rather limited in area, it is considered an important agricultural soil. The average price of the farms ranges from \$15 to \$20 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of the Greenville gravelly sandy loam:

Mechanical analyses of Greenville gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18211.....	Soil.....	1.4	2.8	4.3	37.0	21.8	29.6	3.9
18212.....	Subsoil.....	1.3	1.7	2.0	33.8	17.9	13.9	28.8

GREENVILLE LOAM.

The Greenville loam consists of 3 to 5 inches of brownish to reddish loam or silt loam, underlain by a friable, heavy red clay loam that extends to depths ranging from 24 to 36 inches. Below this the color of the material changes to mottled red and yellow. The subsoil has a somewhat greasy feel when rubbed between the fingers as though composed in part of shale. It always contains a considerable quantity of very fine iron concretions, which tend to make the structure more open and to facilitate aeration and the movement of the soil water.

When handled under proper conditions of moisture, the soil turns easily and no unusual difficulty is experienced in the preparation of an excellent seed bed. If plowed when too wet, however, a great deal of trouble is experienced in subsequently securing good tilth.

The Greenville loam occurs only in small areas in the vicinity of Gansville. It is locally known as "red land" or "mixed land." The latter term results from the association of this soil with the Greenville gravelly sandy loam and the Susquehanna clay and seems to represent a condition intermediate between these two types. It is prized very highly for cotton and corn. It occurs in larger areas in the adjoining parishes to the north and extends on into Arkansas.

The usual topography is slightly rolling to nearly level, the areas being associated with Susquehanna clay, which has similar topography. The drainage is only fair and, although the subsoil is kept

somewhat open and porous by the presence of numerous iron concretions, it is believed that the condition even of the subsoil would be greatly benefited by tile drainage.

The soil is derived from the weathering of the underlying beds of the Lower Claiborne formation.

Cotton yields range from one-half to 1 bale, with an average of about two-thirds bale per acre. Corn gives from 15 to 35 bushels per acre, averaging about 25 bushels. The soil is exceedingly well adapted to oats, but as they are always fed in the sheaf no definite idea of the yield of grain can be obtained. It is estimated that it would be over 40 bushels per acre. The Greenville loam is practically all cleared and under cultivation. It is considered a strong soil, susceptible of improvement, and readily maintained in a high state of productiveness when once in that condition.

As this soil occupies only a few square miles in this parish, it is not so important agriculturally as in some other parishes where it has a larger development. The average price of land of this type, including farm buildings and all improvements, is about \$20 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Greenville loam:

Mechanical analyses of Greenville loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18167, 18166.....	Soil.....	2.6	4.9	3.2	14.8	15.2	50.2	8.6
18168, 18170.....	Subsoil.....	.5	2.3	3.2	13.3	7.5	38.7	34.9

ORANGEBURG FINE SANDY LOAM.

The Orangeburg fine sandy loam consists of 6 to 18 inches of gray or brownish-gray fine to medium textured sandy loam, underlain by material which ranges from a red clayey fine sandy loam to a red fine sandy clay extending to a depth of 36 inches or more. Usually the line of demarcation between the soil and subsoil is quite distinct both in color and texture. In the forested areas, however, this is not always the case. The surface is occasionally strewn with a scattering quartz gravel.

Occurring in rather small disconnected areas, the Orangeburg fine sandy loam is found in all parts of the parish, and especially in the northern two-thirds. It occurs as hills and ridges, and has excellent natural drainage. Owing to its loamy texture, good drainage, and the usual absence of rough surface features, it is very readily brought under cultivation, and it was one of the first soils to be farmed by the early settlers.

The Orangeburg fine sandy loam is derived from the unconsolidated sandy and sandy clay formations which underlie it. These were probably deposited under conditions similar to those existing when the Lafayette was being laid down, though its origin may be of a much earlier date. Originally the land of this type of soil was covered with forests of longleaf and shortleaf pine, with some scattering red oak and hickory. Cotton and corn are the crops, and it is considered a good, safe soil for these in almost any season. The yield of cotton ranges from two-fifths to three-fourths bale per acre, with an average of about one-half bale. Corn ranges from 10 to 25 bushels per acre, with an average of about 20 bushels. It is considered a better soil for corn than for cotton. The above yields are those for crops without an application of commercial fertilizers. By using 200 or 300 pounds of fertilizers per acre, some farmers maintain an average yield of about two-thirds bale of cotton and about 25 bushels of corn per acre. Judging from vegetables and peach trees seen growing in gardens and the success of a few near the towns who have been growing truck on a small scale, the Orangeburg fine sandy loam is one of the best soils in the area for all kinds of small fruit and vegetables, and with the increasing demand for these products it is believed that it would be much more profitable to use the land for these crops than for cotton. In the early days the farmers grew their own tobacco upon this soil, and the success had in growing Cuban filler tobacco upon this same type of soil in Texas suggests that this crop might be profitably introduced here.

Elberta peaches grow to perfection upon this soil and this is another industry whose development is feasible.

The cultural methods on this soil are practically the same as on the other types of the parish. The advantages of deep plowing, of the rotation of crops, and of growing cowpeas or other legumes have been little appreciated. These matters, which have been discussed in connection with soils already described, should be given more consideration by the farmers.

Although the Orangeburg fine sandy loam occurs in rather small, isolated patches, these are so numerous and held in such high favor as to make it an important soil locally.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Orangeburg fine sandy loam:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18203, 18206.....	Soil.....	0.1	0.5	2.5	54.4	13.4	23.4	6.3
18204, 18206.....	Subsoil.....	.1	.3	1.6	38.9	17.1	21.9	19.8

ORANGEBURG SAND.

The Orangeburg sand consists of 10 or 12 inches of light-brown or gray, medium to fine textured sand, underlain by material of the same texture, but of reddish color, extending to a depth of 36 inches or more. At about 24 inches the subsoil sometimes becomes slightly sticky. This is an easy soil to till, breaking into a pulverulent seed bed without tendency to pack or bake.

Small areas of Orangeburg sand are scattered here and there over the western third of the parish, the largest lying in the northwest corner. In topography the soil is rolling to hilly. It occurs upon the divides and narrow ridges of high elevation. This, together with the loose, open nature of the soil and subsoil, insures rapid drainage, which, if anything, is apt to be excessive. As a result land of this type is usually considered of low value in the production of cotton and corn. Over limited areas the surface features resemble sand dunes and, taken as a whole, the soil appears to be the remnant of an ancient beach line.

In some of the more level locations where moisture conditions are naturally the most favorable small areas of the type are sometimes successfully used for general farm purposes. In such locations light truck crops and watermelons seem to do exceptionally well, but in order to keep the soil in a productive state frequent applications of manure and fertilizers are necessary. No peaches were seen growing on the soil and if experimented with it is recommended that only the best and most productive portions of the type be tried.

Being of limited area the Orangeburg sand has little or no material influence upon the agricultural conditions and land values in the parish. Most of the type is still forested with its native growth of longleaf pine and chinquapin. The abundance of the latter and the presence of a weed known locally as "bull nettle" have given rise to the descriptive terms "chinquapin" or "bull nettle" land.

The greatest value of the type lies in its pine timber. Where this has been removed the land can be purchased for about \$5 an acre.

ORANGEBURG FINE SAND.

To an average depth of about 15 inches the soil of the Orangeburg fine sand consists of a light-brown very fine sandy loam. Below this and to a depth of 36 inches or more the material consists of a reddish-brown very fine sandy loam or silty fine sandy loam. Usually there is very little textural difference between the soil and subsoil, the difference in color being the most marked change.

The Orangeburg fine sand is found only in the western part of the parish, where it occurs as a narrow strip extending from the foot of Saline Lake to Petticore Bluffs schoolhouse. The usual topography is

rolling to hilly and the natural drainage is good, although the soil retains moisture very well. It is a residual type derived through weathering from some of the older formations of the Eocene period.

Not only is the Orangeburg fine sand an easily tilled soil, but it is at the same time well adapted to all of the general crops, truck crops, and to sweet and Irish potatoes. It is probably a good soil for the production of peaches and small fruit. The average yield of cotton is one-half bale, and of corn about 20 bushels per acre. Much greater yields, however, are attainable by special care and attention in the preparation of the seed bed and subsequent cultivation of the crop. The soil is very susceptible to improvement, and the effects of manures and fertilizers are both marked and fairly lasting. No crop rotation is practiced. The planters should follow a rotation of cotton, corn, and oats, with catch crops of cowpeas. The cowpeas should be introduced twice in the rotation, first to be sown with corn at the last cultivation, and again sown after the oats are harvested. By this plan the yields of crops can be much increased.

Some of the type has been subject to considerable washing, but this can be overcome to a great extent by growing some of the winter cover crops described under the head of "Agriculture." Terracing would prove very beneficial upon some of the steeper slopes, and side-hill ditches are always beneficial if carefully constructed. Where markets are available a fine opportunity is offered in growing Irish potatoes and watermelons on this soil.

A fair average price for the Orangeburg fine sand is between \$10 and \$15 an acre. It is, or has been at some time, all in cultivation. Though of rather limited extent it is one of the valuable soils of the parish.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Orangeburg fine sand:

Mechanical analyses of Orangeburg fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18199, 18201.....	Soil.....	0.0	0.2	0.4	28.9	36.6	29.6	3.7
18200, 18202.....	Subsoil.....	.1	.3	.3	13.4	42.7	30.9	12.3

SUMMARY.

Winn Parish lies in about the center of northwest Louisiana, and the soils, agricultural practices, and conditions encountered there are representative of those which are common over a considerable part of the hill section of the State in the adjoining parishes to the east and south.

The area was settled about 1840 by white people from Kentucky, Tennessee, Alabama, Georgia, and Mississippi; and these people and their descendants were until about 1900 engaged almost exclusively in raising hogs and cattle. There was very little cotton grown.

The slow development of the parish was due almost entirely to the fact that it was remote from navigable streams, and until about 1900 no railways penetrated the parish. The recent great activity in lumbering and railway construction has stimulated development. More money is in circulation, higher wages are being paid, population is increasing, better schools are being built, and agricultural practices are improving to meet the increasing demands for farm products.

The climate of the parish, besides being well suited to the production of the staple crops of the South—cotton and corn—is also admirably adapted to growing small fruits and truck crops in general.

Only a small per cent of the land has ever been cleared and cultivated, but the present rapid removal of the timber will furnish great opportunities for settlement upon cheap lands and at reasonable terms.

The chief town and trading center of the parish is Winnfield. The parish as a whole now possesses excellent transportation facilities, and when the farm products exceed the local demands it is believed that no difficulty will be experienced in finding an outside market and obtaining reasonable freight rates.

Fifteen types of soil were recognized and mapped. The larger part of the parish is covered by fine sandy loams. The Norfolk, the Orangeburg, and the Susquehanna are the most important series represented. On some of the sandy types it is believed that peaches and a fine quality of cigar-wrapper tobacco could be profitably produced.

A systematic rotation of crops should be followed on all the soils of the area. On the upland sandy soils a three-year rotation of cotton, corn, and oats, with cowpeas sown both at the last cultivation of the corn and after the cutting of the oats, is suggested. All the soils need deeper plowing and a more thorough preparation of the seed bed. The heavy clay types should be tile drained, and a four or five-year rotation would be best upon them. Cowpeas should figure largely in all rotations. The growing of winter cover crops is strongly recommended. Level cultivation on well-drained lands, the use of the check-row system for cotton, the use of better farm machinery, and the growing of more forage crops are all strongly advised.

SOIL SURVEY OF ROBERTSON COUNTY, TEXAS.

By HUGH H. BENNETT and CHARLES F. SHAW.

DESCRIPTION OF THE AREA.

Robertson County is situated nearly in the central-eastern part of Texas, about 140 miles from the coast and 150 miles west of the Louisiana line. It is included approximately between the meridians 96° and 98° west longitude and parallels $30^{\circ} 40'$ and $31^{\circ} 40'$ north latitude. Franklin, the county seat, situated near the center of the area, is 120 miles nearly south of Dallas, 55 miles southeast of Waco, and 115 and 160 miles northwest of Houston and Galveston, respec-

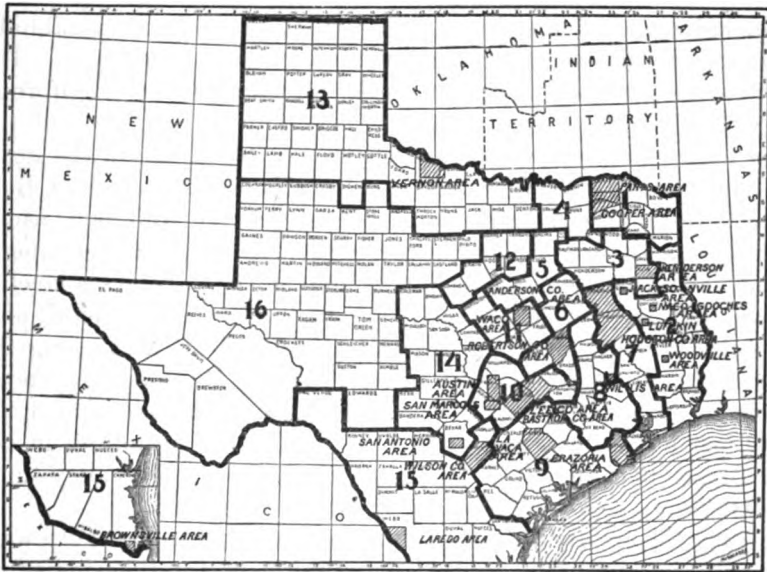


FIG. 19.—Sketch map showing location of the Robertson County area, Texas.

tively. The county is bounded on the north by Falls and Limestone counties, on the east by Leon County, on the south by Brazos County, and on the west by Burleson and Milam counties. The Navasota and Brazos rivers flow along the eastern and western boundaries, respectively, while nearly the whole of the southern boundary is formed by the old San Antonio-Nacogdoches road.

The county contains 545,600 acres, or about 852 square miles. Between 25 and 30 per cent of the land is in crops. Practically the entire area is susceptible of cultivation.

The county lies wholly within the Gulf Coastal Plain and is included in the mixed prairie and timbered belt. About 15 per cent of the area was originally prairie, the balance being timbered with hardwoods, principally post oak, black-jack oak, and hickory in the uplands, and pin oak, post oak, elm, hackberry, cottonwood, ash, and pecan in the bottom lands.

Included between the Navasota and Brazos rivers the area has a slight southeasterly slope in the direction of the rivers. The county is divided into upland and prairie. In the northern half is a mixed prairie and timbered belt, largely gently rolling in topography, which comprises roughly that part of the county north of Mud and North Mineral creeks. In this section there are in the uplands occasional though not extensive stretches of flat land and a number of eminences commanding views of the surrounding country. The greater part of the upland country is also gently rolling, although in some places the surface is quite flat. The surface of the timbered, sandy belt south of the mixed prairie and timbered land is flat to gently rolling, and includes a number of iron-ore-capped knolls and occasional hills. There are in this section also a number of small "prairies." The narrow strip of prairie along the southern boundary has a uniformly gently rolling surface.

The most striking topographic features of the area are the occasional prominent hills, like those east of Hayes and south of Bald Prairie. Along the Houston and Texas Central Railroad, which follows along the slope between the Brazos bottom and the general upland, there is a rise in the elevation from 300 feet above sea level at Benchley, on the southern county line, to 498 feet at Bremond, near the northern line. Crossing the upland part of the area along the route of the International and Great Northern Railroad, the elevation ranges from 310 feet at Hearne to 445 feet at Franklin, then drops to 340 feet at Easterly and to 314 feet at Lake. Mumford, in the lower Brazos bottom, has an elevation of 265 feet, while Valley Junction, 9 miles up the bottom, is 283 feet above sea level.

Crossing the county near its center and passing through Petteway, Grant Prairie, Franklin, and Henry Prairie is a rather indistinct divide between the drainage areas of the Navasota and Brazos rivers. A number of important streams rising in this region have cut deep valleys on their way to the main water courses. Along the principal creeks are bottoms of rich alluvial soil varying from narrow strips to three-quarters of a mile in width. The valley walls of a number of streams, like Mud, Mineral, and Cedar creeks, are in places quite steep, rising suddenly to the general upland level. The country in the neighborhood of stream courses is generally rolling and sometimes quite broken. Steele Creek, rising in Limestone County and flowing across the northeast corner of Robertson County, has a broad

bottom and gentle slopes to the upland. The upper courses of the streams flow through deep gullies, known as "dugouts," and carry water only part of the year. Some streams, like Cedar Creek, are fed by springs and have running water the year round. Several creeks have had their channels obstructed by material washed in from the upland, especially in their lower courses. Mud and Walnut creeks have filled in so that their one-time notably productive bottoms have become subject to more frequent overflow, and consequently have depreciated in value within the last decade. The general drainage of the upland is excellent. There is very little erosion further than a gradual advance of the "dugouts," which frequently is of benefit, especially to the flat stretches, by broadening the drainage system.

The Navasota bottom varies from a few rods to about 1 mile in width. This bottom is uniformly flat, interrupted by crossing streams and occasional sloughs, and is subject to frequent overflow. The Brazos bottom proper embraces all the territory between the Big and Little Brazos rivers and an irregular strip east of the Little Brazos. It averages about 5 miles in width near the southern county line, narrowing down considerably toward the northern line. The width of this alluvial land in Robertson County is very irregular and varies with the meandering course of the Brazos River along the western boundary. At a point west of Hammond the width is about one-half mile only. In the bend at the junction of Hardin's Slough and the Big Brazos the bank has given way and the river approaches within a quarter of a mile of the Little Brazos.

The bottoms, except for sloughs and occasional hummocks, are nearly flat. There is a very gentle slope away from the rivers, forming a slight and almost imperceptible ridge midway between the two streams.

In several places adjacent to the bottom lands there are higher-lying flat stretches of considerable extent which have the appearance of well-defined second bottoms. The flat country west of Calvert and Wootan Wells slopes very gradually away from the Brazos bottom bluff line to blend with the general uplands. These flat stretches evidently were influenced by the waters of the Brazos in the early stages of the river's development, notwithstanding that the soil mass, except possibly a shallow covering, consists of the same material as the adjacent upland soils.

One of the earliest settlers in Robertson County was a Mr. Dawson, who took up land in the Brazos bottom about 1830. In 1833 some Irish families came in from Alabama and settled west of Wheelock. A considerable portion of the area was surveyed and taken up that year. Most of the earlier settlers came from the older Southern States, mainly from Tennessee, Mississippi, and Alabama. These brought

wagons, teams, some cattle and hogs, and farm implements. Germans began to settle in the New Baden neighborhood in the early eighties. A considerable number of Poles have settled in the vicinity of Bremond within the last twenty-five years, and a few Italians and Bohemians are coming into the county. These foreign settlers have generally made thrifty and successful agriculturists. A number of northern people have recently settled in and around Franklin.

Robertson County was organized in 1837. Its area has been reduced considerably by taking from the original territory certain portions for the organization of other counties. The county is a part of the area that constituted Robertson colony.

The farmers of the Brazos bottoms generally have prospered and a number have amassed considerable fortunes. Although these bottoms were among the first tilled lands of the area, they were considered unhealthful in the earlier days. Since the greater part has been put under cultivation the sloughs have largely dried up, and this, coupled with the securing of excellent artesian water, has improved the conditions until the bottom land is about as healthful as the upland. While substantial homes are seen on many of the bottom plantations, a large number of the owners live in Hearne, Calvert, and Bremond. The majority of the negro population lives in this section. Farms here have comfortable houses for the tenants and laborers, as well as substantial barns, cotton houses conveniently located through the fields, and frequently gins.

On the uplands the farmers have always made a comfortable living. Many farms have substantial dwellings and outbuildings, particularly the prairies of the northern and southern parts of the county. Many fields are inclosed with good wire fences. Telephones and rural free delivery of mail are making country life less isolated, and churches and public schools are quite convenient in most parts of the area. Public roads could be improved by rounding up their beds and covering with sand or clay, accordingly as the original roadbed material is clay or sand.

Franklin, the county seat, has a population of about 1,500, while Hearne, Calvert, and Bremond have about 2,000, 4,000, and 1,500, respectively. The population of the county was 31,480 in 1900. Good transportation facilities are afforded in the central part of the county by the International and Great Northern Railroad, and in the western part by the Fort Worth division of the International and Great Northern and the Houston and Texas Central, which traverse the Brazos bottom and the adjacent slope, respectively. The Hearne and Brazos Valley Railroad runs from Hearne through the lower Brazos bottom. Marketing the produce is quite a problem with the farmers of the northern and southern parts of the county. Railroads are badly needed in these sections.

Over most of the area cotton gins are conveniently located. Compresses are situated at Hearne and Calvert. Franklin, Hearne, and Calvert are cotton markets of considerable importance. Cotton is also sold and shipped from other points like Easterly, New Baden, Mumford, and Bremond. Little manufacturing is done in the county except the manufacture of cotton-seed oil at Hearne and Calvert. There is a canning factory at Franklin. Truckers and fruit growers should, through organization, give mutual assistance in securing markets and in obtaining favorable shipping rates.

CLIMATE.

The following table, compiled from the records of the Weather Bureau as observed at Hearne, at College Station, just south of the area, and at Waco, about 40 miles to the northwest, gives the normal monthly and annual temperature and precipitation at these respective stations:

Normal monthly and annual temperature and precipitation.

Month.	Hearne.		College Station.		Waco.	
	Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.
	° F.	Inches.	° F.	Inches.	° F.	Inches.
January.....		2.45	49.8	4.33	48.1	2.73
February.....		1.82	52.1	2.35	50.0	1.93
March.....		2.61	59.9	2.50	58.6	3.04
April.....		3.85	68.1	3.42	67.8	4.49
May.....	76.0	4.25		4.76	75.7	4.64
June.....	81.3	3.21		3.70	82.4	3.98
July.....	84.1	2.21	82.4	2.25	85.4	2.00
August.....	82.3	1.83	83.0	1.87	84.8	2.08
September.....	77.8	3.13	78.2	3.98	78.4	2.90
October.....	68.8	2.65	69.1	2.32	68.3	2.41
November.....	57.1	3.46	58.1	3.39	57.3	2.79
December.....	49.9	2.62	52.8	3.54	51.0	2.06
Year.....		34.09		38.41	67.3	35.05

The annual rainfall of about 34 inches, when distributed uniformly, is sufficient to meet the demands of all crops. April and May are considered the months of heaviest precipitation, while June and July, although with a fair average rainfall, are counted as a season of uncertain weather and subject to droughts. Dry weather during these months is apt to cut short the corn crop. It is claimed that little success can be had with fall Irish potatoes on account of the unevenly distributed rainfall during the season. The best rains generally come from the northwest. Gulf clouds are not indicative of good summer rains.

The winters are generally mild. Light snows sometimes fall, but zero weather is rare. The summers, though long, are not as

warm as the latitude would suggest, on account of a moderating breeze from the Gulf. The mean monthly temperatures for June, July, and August, which comprise the hot season, are 82°, 85°, and 84° F., respectively. During winter and spring "northers" may be expected at any time. These sudden drops in temperature accompanied by winds from the north continue from two to five days. Sometimes fruit, particularly the peach crop, is damaged by the "cold snaps" coming with northers.

The unusually mild winter of 1906-7 caused peach trees to bud and even bloom as early as January, with the result that subsequent freezes did great damage both to the crop and the trees. The crop was practically cut off, while the vitality of the trees was so impaired that many died later. Those on the high-lying, well-drained soils withstood the unfavorable conditions best. The early spring caused old cotton stalks to sprout, affording sustenance to early boll weevils. The early planted cotton was so injured and retarded by the cold weather of April and May that much replanting had to be done. Corn was not seriously injured. Such unseasonable weather, however, is very rare.

The average date of the last killing frost in spring is about February 26 and the first in fall about November 17. While vegetation has been killed as late as the middle of April, damage is very rarely done to general farm crops by frost. The bottom lands are considerably earlier than the average of the uplands, particularly the deep sandy uplands. A large part of the Irish potato crop is planted in February, and corn any time from the middle of February to the first of April. In the effort to make a crop of cotton before the boll weevil becomes most active, planting is generally done much earlier than was the custom prior to the advent of this pest. Planting is done at any time from the 10th of April to the middle of May. The normal climatic conditions are well suited to cotton. It rarely happens that less than a fair crop is made on account of unfavorable weather conditions. With all crops injury from drought can be lessened considerably by the timely breaking up of crusts formed by rains and by keeping the surface soil continuously well mulched, with frequent shallow cultivations.

AGRICULTURE.

Under Mexican rule settlement was encouraged by granting the head of a family a league and a labore, and an unmarried man one-third of a league of land. Three years' occupation, the cultivation of a stipulated acreage, and possession of a certain amount of stock were required to obtain title. Certain officers of the army and government were granted 11 leagues. These claims were respected after the establishment of the Republic of Texas in 1836. The new Republic encouraged homesteading by granting "head rights" of a league and

a labore to married men and one-third of a league of land to unmarried men upon practically the same terms as the Mexican grants. This was changed later so that the head of a family received 640 acres and a single man 320 acres. The homesteader was required to pay the cost of the survey and fees of certification and title. Honorably discharged soldiers were allowed to take up certain areas of unclaimed land as "soldiers' rights" without actual occupation.

The first settlers lived in a primitive manner. Situated far from markets, they grew for home use small patches of potatoes, corn, and vegetables, and raised a little stock. There was a tendency to settle in communities for the advantages of mutual protection against the Indians. Generally the most convenient lands were cultivated. The sandy timbered soils were preferred for potatoes and vegetables, while the "red lands," the Orangeburg soils, were selected for corn. Prairie land was not so generally sought after, as it was considered harder to cultivate and not so productive. As it was soon learned that hogs and cattle could be successfully raised with little attention in the timber ranges and on the prairies, stock raising became the dominant industry among the early settlers. Steers were driven to Houston, where they sold for about \$1 per hundred pounds. Settlers were not slow in recognizing the adaptability of the soils to cotton, and its cultivation began in the late thirties, slave owners being among the first to take it up. The establishment of a cotton gin at Wheelock in 1839, properly speaking, marks the beginning of agriculture in Robertson County. The production of cotton was quite limited at first, only about 429 bales being produced as late as 1849. The Brazos bottom soils were among the first used for the cultivation of cotton. The first crops were hauled to the Trinity River and rafted to Galveston. Agriculture made very little headway before 1845 on account of hostilities with Mexico. Oats were introduced in the Wheelock neighborhood about 1845. Wheat was later introduced and made some good yields on the prairie and "red lands," but owing to the absence of mills and a general belief that climatic and soil conditions were unsuited to it the crop has never found much favor.

By 1859 the agriculture of the county had attained considerable importance. That year 6,467 bales of cotton, 141,439 bushels of corn, 11,425 bushels of sweet potatoes, and 1,272 bushels of wheat were produced. The live stock was valued at \$574,984.

The effects of the civil war were not felt so severely as in the older Southern States. The census of 1870 shows by the cotton and corn crops of 1869 that agriculture had nearly regained the position it held at the opening of the war. The estimated live-stock valuation of only \$120,335 shows, however, that this industry declined enormously during the decade ending in 1870. The opening of the railroads about this time gave considerable impetus to settlement.

The production of cotton and corn increased from 4,833 bales and 140,083 bushels, respectively, in 1869, to 18,080 bales and 422,889 bushels in 1879, while live stock increased in value to \$439,948. The census of 1900 showed no marked agricultural progress for the decade ending that year. Notwithstanding an acreage increase of about 25 per cent the yields of cotton and corn were 34,919 bales and 713,800 bushels, respectively, as against 32,307 bales and 734,125 bushels for the year 1889. These figures are probably not commensurate with the actual progress made, inasmuch as crops were considerably damaged by the "June flood" of 1899, which was caused by the heaviest rainfall in the history of the county. It is claimed that the deep sandy lands are just recovering from the deterioration suffered during this rain. The value of farm stock increased during this period from \$701,210 to \$1,035,710.

The production of oats seems to have decreased since 1889, the estimated yields for the years 1879, 1889, and 1899 being 36,873, 41,242, and 20,960 bushels, respectively.

The boll weevil has been the most destructive cotton pest in the history of the county. The last good cotton crop prior to the time of the boll weevil depredations was that of 1899. Most damage was done in 1903 and 1904, the county producing 13,960 and 23,413 bales, respectively, for these two years. Large fields failed to produce enough to warrant picking. The serious depression caused by this pest compelled farmers to turn their attention to diversification and better methods of soil management. Truck farming has proved profitable and seems to be established on a permanent basis in some sections, particularly in the vicinity of Franklin, where the conditions are well suited for it. The production of early Irish potatoes for shipping has increased considerably. The peach industry has received such an impetus that many large orchards, some at a considerable distance from the railroads, have been set out. While many orchards have not yet come into bearing, the good results had with the older ones are indicative of the success of the fruit industry.

A considerable number of deserted farmhouses bear evidence of the uneasiness that existed in the earlier years of the ravages of the boll weevil. Many renters and laborers, and even landowners, migrated to west Texas and Oklahoma. Since 1904 better crops have been made. The 1906 cotton crop, amounting to 44,067 bales, was the best grown in years. In many sections the yield was considerably higher than the average. As a result farmers have recuperated from past losses, are largely out of debt, and seem more hopeful and prosperous. More improved machinery is being used and the general outlook is favorable.

At present the prevailing practice throughout the uplands of the county is general farming, which is frequently carried on in conjunc-

tion with more or less stock raising. With the increase of population and increased acreage of fenced farm land, exclusive stock raising has gradually given way to the present system, until there are only a few "ranches" or farms devoted entirely to stock. These are confined largely to the prairie region in the southern part of the county.

That agriculture has assumed the dominant place among the industries has been the inevitable outcome of the admirable adaptation of the soils to cotton. This crop has been grown since the time of early settlement and until recently was depended upon as the sole money crop. About 65 per cent of the cultivated land is devoted to its production. The fertile Brazos bottom is cultivated largely to cotton, only a comparatively small acreage being in corn and alfalfa.

Of late years not enough corn has been grown to supply the wants of the upland farmers. With favorable seasons and proper cultivation the uplands yield from 20 to 40 bushels and the bottom lands from 30 to 75 bushels per acre. Excepting the "prairie hay" of the southern part of the county and the alfalfa of the Brazos bottoms, practically no hay has been grown. Recently Johnson grass and Bermuda grass have been recognized by some farmers as valuable for hay. The creek bottoms are especially suited to these crops, and owing to the difficulty of cultivating such land where either of these grasses has taken firm hold a considerable acreage has been converted into meadow or hay lots. Notwithstanding the fact that a large proportion of the soil of the county is well adapted to one or the other or both these grasses, which make excellent hay, they generally are considered as pests and there are but few instances where either has been sown.

The Miller soils are especially adapted to alfalfa, producing from three to five or even six cuttings. Normal climatic conditions are favorable to the successful curing of the crop and but little damage should be done by rains where ample machinery for quickly harvesting the crops and suitable barns for storing the hay are provided. The acreage was largely increased during the period of the boll weevil depredations. In view of the strong demand and good prices for this hay, it would seem that the acreage could be profitably increased.

With seasonable weather, fall-sown oats do fairly well. While 10 to 20 bushels of wheat per acre have been grown on soils like the Crockett clay loam, Orangeburg fine sandy loam, and Susquehanna fine sandy loam, the crop has never taken a firm hold and none is grown at present. Rye would do fairly well and would afford excellent winter and spring grazing, and undoubtedly would prove valuable as green manure if plowed under preceding potatoes. Sugar cane is very successfully grown as a sirup crop, especially on bottom lands, where the yields are from 200 to something like 600 gallons per acre. The yield of sirup per ton of cane is considerably higher in the bottom

grown product. If the stubble is covered with soil in the fall two or more good crops can be made from one planting. Sorghum is a profitable sirup and feed crop. Sweet potatoes of good flavor and keeping qualities can be grown on nearly every type of soil. This crop deserves greater recognition, as only a few bushels are shipped and often not enough are grown to supply the local demand. Irish potatoes also do well on nearly all the sandy soils. Though the average yields run from 80 to 150 bushels per acre, there are several instances where with heavy applications of barnyard manure and intensive cultivation a yield of something like 200 bushels has been made. The early crop has proved quite profitable. The production of Irish potatoes has greatly increased since the advent of the boll weevil and probably will continue to increase. In growing this crop it is advisable to choose high, well-drained ground with the object of getting a good quality and affording protection from frost. The Susquehanna fine sandy loam should be deeply broken and the Norfolk fine sand broken to a comparatively shallow depth to get the best yields of good potatoes.

The fruit and trucking industries are attracting much attention, especially in the vicinity of Franklin. Those trees that have come into bearing indicate that an excellent peach can be grown. It is claimed that the trees, especially budded stock, are short-lived on soils like the Susquehanna fine sandy loam and Crockett clay loam, possibly owing to their stiff, impervious subsoils, but in general too little attention has had something to do with this failure. Peach trees here seem quite responsive to good cultivation. Pear trees grow well, but frequently suffer from blight. The Kieffer pear does well and seems most resistant to the disease. Nothing is done to check the spread of blight. Plums and figs can be grown very successfully. Not infrequently two good crops of figs are grown in one year. The trees sometimes are weakened by freezing of the late fall growth. Large early blackberries and dewberries of good flavor and shipping quality are grown with profit. These crops are rarely cut short by unfavorable weather. Some strawberries are grown in the immediate vicinity of Franklin, but too little attention has been given the crop. The coarser sandy soils seem especially suited to strawberries. Several small vineyards were seen in the area. Grapes could be grown successfully on the Norfolk soils.

Early Irish potatoes are the leading truck crop. Some late tomatoes of extraordinarily good quality have been produced on the Miller clay. Early spinach, lettuce, radishes, English peas, onions, turnips, and beans can be grown very successfully on the better drained upland sandy loam and gravelly soils. Watermelons, cantaloupes, and cucumbers do well on the sandy soils. Peanuts do well on all the sandy soils, and when grown in conjunction with oats,

rye, and cowpeas offer opportunities for the more extensive raising of hogs. Recent good prices have turned the attention of a number of farmers toward this method of fattening hogs for market. Feeding them on corn alone is not profitable. The industry is now of considerable importance and carloads of hogs are shipped yearly. Sheep and goats can be raised with practically no expense, and a large number of the farm horses and mules are raised in the county, though very few are marketed. The longhorn cattle and the razor-back hogs are being displaced gradually by better breeds.

The subject of adaptation of soils to crops is more specifically treated under the heads of the several soil types.

The long-standing practice of cultivation without rotation of crops and without restoring anything to the land has nearly exhausted the organic matter content of a considerable part of the sandy upland. Fields are grazed during the winter, then burned over so as to get them clean before breaking. Even corn and cotton stalks are frequently burned. In short, the methods practiced have been such as to decrease the productivity of the soils. Notwithstanding these ill-advised practices, much of the land has held up surprisingly well, many fields that had been under cultivation continuously for thirty years or more making excellent crops of cotton in 1906. The deep sandy soils have deteriorated most. The newly cleared Norfolk fine sand declines in productiveness after growing five or six crops of cotton. Such land after "lying out" for a few years will again make a fairly good crop for a year or two. A considerable proportion of the cleared "hard" post-oak land, like the Susquehanna fine sandy loam, is comparatively new and has not yet showed much evidence of deterioration. Some of the older fields in the prairies are beginning to run down.

A few of the better farmers have learned the value of cowpeas in building up impoverished land. The usual practice is to sow cowpeas in the corn at the last plowing, turning on the stock after the removal of the corn.

A good rotation is cotton followed by corn, with cowpeas at the last plowing. This can be lengthened to include in the third year a crop of cowpeas or oats followed with cowpeas. Cowpeas following a crop of early Irish potatoes gives time for fall plowing and putting the land in excellent condition for either cotton or corn. Many farms could be profitably divided so as to allow a convenient and more nearly even distribution of crops. While many object to anything like an equalization in the acreage of cotton and corn, it is plainly evident that such a plan would work to the advantage of a large number of farmers, particularly those who are buying corn. Rotations can be worked out to suit the ideas of the individual, but in every case the object of prime importance should be the incorpora-

tion of some form of vegetable matter in the soil at frequent intervals to maintain a good supply of humus. Many farms could be fenced and connected with a centrally located lane leading to the barn, so that the various fields could be pastured conveniently from time to time in favorable weather. "Dead spots," or areas affected with cotton root rot or some other disease that kills the cotton plants, could be improved by rotation.

Cowpeas improve land whether grazed, cut off, or turned under. Occasionally a crop turned under green would be of benefit, particularly in case of the lighter types of soil. Besides improving the land, cowpeas can be made a profitable crop by cutting the pea vines for hay, which makes a palatable and nutritious feed for all kinds of stock. Peanuts also have a beneficial effect upon the soils, restoring more or less organic matter. Matured crabgrass, if plowed under late, is not apt to decay in a dry winter like that of 1906-7 and leaves the soil in a rough, unwieldy condition, particularly on the Norfolk sand and fine sand. Increased yields are secured after alfalfa, even on the richest of the Miller soils. In getting and maintaining a good stand of alfalfa it is not advisable to graze the first year, nor in the early spring when the plants have not fully recovered from the effects of winter. Alfalfa should always be sown in the fall so as to get a start ahead of the grass and weeds. After four years it is usually followed by cotton and corn. It is advised that cotton stalks in the uplands be cut and plowed under early in the fall rather than in the late winter or spring.

No fall plowing is done after cotton and very little after corn. Plowing begins early in January, and much is done just preceding planting. Land is broken and prepared for the seed bed at a single operation.

Cotton is usually drilled in rows, which in the bottom land are usually 4 feet and on the upland from 3 to 3½ feet apart. After the plants have grown sufficiently the rows are thinned, some of the plants being "chopped out" to allow the remaining plants greater freedom to grow. At the first chopping the stand is thinned down to hills of 1 to 3 stalks, averaging about 1 foot apart in the row. The soil between the rows, or the "middle," as it is called, is then broken and the earth thrown toward the plants, after which a 16 or 18 inch sweep is run down between the rows to get rid of weeds as often as it is found to be necessary. The sweeps serve the additional purpose of loosening up the surface soil around the plants and of conserving the moisture by forming a surface mulch. In the Brazos bottoms and occasionally in the uplands cultivators are used with good results. Harrowing is sometimes done, but the practice is generally considered too expensive or too intensive a method of cultivation. Crusty land like the Susquehanna fine sandy loam or Wilson fine sandy loam especially

would be benefited by harrowing diagonally across the rows after the plants are well started. Light harrowing or running over with a weeder before the cotton is up would be beneficial in many instances where crusts hinder the sprouts from breaking through. Cross harrowing is not advisable where the stand is poor. It is rarely economical to plant sparingly of seed.

The efficiency of frequent cultivation has been proved in the case of cotton in the Brazos bottoms, where by plowing frequently whether there was grass or not and hoeing five or six times, some good crops were grown during the worst boll-weevil years. It is too frequently the practice to use extra labor to cultivate extra land instead of cultivating more intensively. Twenty acres is enough for one plow.

Corn is always planted deeper than cotton and on ridges opened with shovels or in the water furrows or in the "streaking off" furrows. The cultivation is about the same as for cotton, though not continued as long. The crop is "laid by" always on a ridge and generally three to five weeks earlier than cotton. That planted on a ridge seems to grow off faster than that planted in the water furrow, but it is claimed that plants suffer less from drought in the latter case. Particularly good results are had from planting in the water furrow in the Brazos bottoms. Frequent and more nearly level cultivation over a longer period would be the ideal method of corn culture on deep, flat-broken land in case such land is considered uncertain on account of June and July droughts.

There is a tendency to plow corn stubble deeper and earlier for the following crop than cotton land. The present system of shallow preparation of deep sandy land is sufficient for all needs. The heavier lands, like the Susquehanna fine sandy loam and the Miller soils, need deeper and earlier plowing so as better to conserve the winter rains, especially where intended for corn, as the crop is considered uncertain under present methods of treatment on account of June and July droughts. Flat breaking in the fall should be practiced whenever practicable on these heavier types. When light surface soil is underlain at about 4 to 10 inches by a heavy subsoil the land would be generally benefited by turning a thin layer of this heavy portion to the surface in the fall and later during the winter and spring working it into the soil, thus increasing the loaminess. Occasionally land is broken with disk plows with good results. Johnson grass can be killed by repeated shallow plowing in hot, sunshiny summer weather. A very effective method is as follows: First year, graze close to bring the root system near the surface or weaken by smothering with some fast, thick-growing crop like sorghum or millet; second year, kill out by shallow summer plowing; third year, cultivate cotton intensively and absolutely clean, hoeing after discontinuing the use of plows to destroy every sprig of grass. Oats are sown broadcast, turned under

with turning plows, and then left to take chances on a poorly prepared, rough, and very unfavorable seed bed. Better results would be had with thorough breaking, harrowing, and seeding with drills in the fall.

Flat soils having poor surface drainage need open ditches to remove excessive rainfall. Ditches dug on both sides of a "turn row," throwing the dirt to the road between, have proved very effective in the case of the low-lying Miller clay and silt loam.

Scarcity of labor is a problem of much concern. In the eastern part of the county much of the labor is done by the immediate family of the farmer, while in the western part, particularly in the Brazos bottom, farm labor is drawn almost entirely from the negro population. Day laborers are paid from 75 cents to \$1.25. Seventy-five cents to \$1.25 per 100 pounds is paid for picking cotton.

The census of 1900 estimated that 31 per cent of the farms were operated by owners. The percentage probably is greater now on account of considerable emigration of the tenant class during the boll-weevil period. The greater number of the tenants farm on "halves," the landlord furnishing everything except the tenant's board and receiving one-half the crop. When the owner furnishes only the land the tenant usually gets three-fourths of the cotton and two-thirds of the corn crop. Much of the Brazos bottom land rents for \$5 to \$6 cash an acre. Some land here is worked on the "turn back" system, so much per acre being given for growing a crop, not including harvesting.

Farms vary greatly in size. Some of the upland farms are small, while others contain 2,000 acres or more. Brazos bottom farms are generally large, many containing 1,000 acres. The price of land has increased in the last two years. Grazing and timber land can be bought in the Navasota bottom for from \$2 to \$5 an acre. Timbered upland can be bought for about \$4 to \$15, according to distance from the railroad. Good prairie land is held at \$8 to \$15 an acre. Some land nearer the towns is held at higher prices. The better Brazos bottom land averages in valuation something like \$60 to \$75 an acre, with little on the market. Farms subject to overflow or infested with Johnson or Bermuda grass can be bought cheaper. The settlement of the west Texas country, which at present is receiving the greater share of a rapidly increasing immigration, will turn attention to this part of eastern Texas, where a large area of good land is awaiting development. Excellent opportunities are afforded the man of small capital, as it is practicable to secure good farms for a small cash payment and pay the balance with the proceeds of two or three crops.

The use of fertilizer of any kind had been very limited until 1906, when considerable quantities of commercial fertilizers were tried in

an experimental way for cotton and Irish potatoes. The results were such that a much greater quantity was used this year. For cotton, applications of ordinary grades of complete fertilizers have been made at the rate of 200 pounds to the acre, distributed in the water furrow and bedded in. Irish potatoes seem especially helped by the use of cotton-seed meal. Fertilizers have found but little favor in the fertile Brazos bottoms. As yet farmers are not well acquainted with the nature of fertilizers or the cheaper and better methods of home mixing of fertilizer ingredients. However, it seems that commercial manures are destined to come into general use in the uplands, as has been the case usually in the older States whenever once tried. The use of this class of fertilizers to the exclusion of organic manures, like barnyard manure or cowpeas, is not to be recommended. The effect of commercial fertilizers used alone is neither as good nor as lasting as when used in connection with some form of vegetable manure.

Cotton seed deadened by heating is coming into use in those sections where distance to market prohibits the economical sale or exchange of seed for cotton-seed meal. Very good results have been had with both cotton and corn by the application of 1,000 pounds of seed as fertilizer to the acre. Barnyard manure has never been credited with its true worth, for the reason that few farmers have used it or properly handled it. This form of manure, protected from the weather, especially from the leaching of rains and from overheating, is the best manure that can be used on the soils of the area. It adds vegetable matter which is badly needed and is the best form of fertilizer for correcting the mechanical condition of the soil and starting desirable fermentation in the soil. Farmers fear the use of barnyard manure wherever Bermuda or Johnson grass has been fed, and consequently much good stable and stockyard manure goes to waste.

Although new varieties of cotton were widely sought after and used in attempts to grow an early crop so as to forestall the boll weevil, far too little attention has been given the matter of seed selection in general. Some of the varieties of cotton grown show an inherent tendency to produce sparingly of small-sized bolls, while others go largely to stalk. Farmers should exert every effort to secure better varieties by selecting seed from the best home-grown plants. It is reasonable to assume that the corn yield could be materially increased by selection of seed from the more virile plants. The seed should be taken from the best all-around plants on a particular soil and planted on the same soil and not indiscriminately on all soils. This method of selection for both cotton and corn should be thoroughly tried, at least, in an attempt to improve varieties. It is known the cotton bred upon a certain soil may lose its improvements when grown on a soil with very different characteristics.

In their efforts to meet the ravages of the boll weevil the farmers of Robertson County have become imbued with a new spirit and are gradually working out better methods and enlarging the scope of agriculture. When it is considered that there is great room for soil improvement and restoration through rotation and the use of vegetable manures, that susceptibility to drought can be appreciably reduced by deeper preparation and shallow cultivation, and that diversified farming is yet in its infancy, it becomes plainly evident that there is good opportunity for a much greater agricultural development in this county. Fruit and truck growing, particularly the production of early Irish potatoes, sweet potatoes, tomatoes, and a great variety of vegetables, can be successfully carried on in conjunction with general farming, and to a certain extent with stock raising, over a large portion of the area. The great variety of soils and the great variety of crops to which these soils are adapted, coupled with the low price of land, makes the county one of the most desirable of the eastern Texas counties to the man of moderate means who desires to engage in diversified farming. It is easy to make a good living here, and there are excellent opportunities to make money.

SOILS.

The soils of Robertson County, classified according to origin, fall into two groups—sedimentary, as represented in the upland soils, and alluvial, or the bottom lands of streams.

The sedimentary soils consist of materials washed in from contiguous land areas and laid down in the sea which once covered this part of the country. The coarser materials—the sands—settled first in the shallow water near shore, while the finer particles—clay and silt—were held in suspension longer and carried farther out, to be laid down as offshore or deep-water deposits. The materials thus assorted by water and again commingled by wave and tide action gave rise to sands, clays, sandy loams, clay loams, etc. The extensive bodies of sand like those of the Norfolk fine sand probably represent shore-line deposits or materials assorted out and thrown up by waves and tides as the sea gradually receded. It is probable that there were times when the area was not entirely submerged, which admitted of variation in the deposited material, inasmuch as the soil washed in at a given time may have been derived from quite a different source from that of earlier deposits. At one time there prevailed over a considerable portion of the northern part of the county a marshy condition which was conducive to the growth of water-loving plants, accumulations from which were later submerged and covered by deposition of materials washed in from land. In this way the lignite deposits of this section of the county were formed. Geologic-

ally this portion of the county represents the lignitic stage of the Eocene-Tertiary. Other conditions were favorable to other formations, as, for instance, the impure limestones which in places underlie the prairie lands in the southern part of the county. These limestone formations have materially influenced the character of the soil here, and it is possible that the black areas in the prairies of other sections of the county may in some instances owe their peculiar dark color to influences of local occurrences or accumulations of lime. The red color, the conglomeritic iron sandstone, and iron concretions of the Orangeburg soils probably originated largely under peculiar conditions favorable to aeration and subsequent oxidation of the iron components of the soil, which processes have taken place since the emergence of the sedimentary material.

Thus it is seen that a considerable number of influences and varying conditions have had to do with the great differences in the character of the upland soils.

The alluvial soils of the stream bottoms represent material brought down in suspension and deposited from overflow water. The material of the Brazos bottom soils was brought from the red lands of the "Panhandle region" of northwest Texas, while the black deposits of the Navasota bottoms were brought down from the "black lands" and in less quantity from the great variety of mixed soils that occur within the drainage basin of this river. The striking contrasts between the red or chocolate Brazos bottom lands and the black land of the Navasota bottoms illustrates the wide differences that may exist in alluvial soils derived from drainage areas embracing unlike geological formations.

Twenty-seven distinct types of soil exclusive of Meadow were recognized and mapped. These have been classified into sands, clays, sandy loams, clay loams, silt loams, etc., according to their texture or content of sand, clay, and silt as determined by mechanical analyses of representative samples. These types have been, where possible, correlated with previously studied and named soils and grouped into series distinguished by a number of marked differences.

The Norfolk series is quite extensive and consists of grayish, loose, light-textured soils underlain by grayish, pale-yellow or yellow sand to friable sandy clay. The subsoils are not as a rule as light and friable as the average for this series farther east.

The Lufkin series contrasts with the Norfolk in its darker colored and more compact soil and grayish to yellow, very stiff and plastic, subsoil. The topography of the Lufkin soils is generally quite flat.

The Susquehanna types are distinguished by the mottled red, yellow, and drab plastic subsoils. The Susquehanna fine sandy loam is the most extensive type of the area. Its topography for the most part is gently rolling.

The Crockett soils are quite variable in color and texture. Within small areas the soil texture of some of the members may vary considerably while the subsoil may change in color from nearly black to red, the prevailing color being red. The deep subsoil in some places contains lime concretions. These soils appear to belong to a transitional series of peculiarly mixed or variable soils coming between the Susquehanna and the Houston or limy soils of the "black lands." Although these soils have probably been influenced by the underlying calcareous material, they have been largely derived from the more recent sedimentary deposits, the material of which is very similar to that of the Susquehanna soils.

The Orangeburg soils correspond quite closely to the Norfolk types in texture and structure of surface soil, but differ in the color of subsoil, the Orangeburg being red instead of yellow. The subsoils are not as sandy and friable as is characteristic of the series farther east.

The Wilson types are characterized by their black color and very stiff subsoils, the growth of mesquite, and their tendency to harden in dry weather or crust on the surface of cultivated fields after rains.

The Wabash clay embraces the black alluvial soil which has been brought down by the Navasota River from the Black Prairie region; the Miller series the red or chocolate alluvial types, which have been brought down by the Brazos River from the Permian Red Beds, while the Sanders soils are of local origin.

The following table gives the names and extent of the soils of the county:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Susquehanna fine sandy loam	143,424	26.3	Orangeburg gravelly sandy loam	5,376	1.0
Norfolk fine sand	130,560	23.9	Crockett fine sandy loam	4,416	.8
Miller clay	44,608	8.2	Miller fine sandy loam	4,352	.8
Orangeburg fine sandy loam ..	29,888	5.5	Wilson fine sandy loam	4,288	.8
Norfolk fine sandy loam	27,776	5.1	Orangeburg sand	4,096	.7
Lufkin fine sandy loam	26,944	4.9	Norfolk sand	3,456	.6
Miller silt loam	18,560	3.4	Susquehanna loam	3,392	.6
Crockett clay loam	15,616	2.9	Crockett gravelly loam	3,008	.5
Wabash clay	14,528	2.7	Lufkin fine sand	2,432	.4
Sanders silt loam	10,880	2.0	Lufkin clay	2,176	.4
Meadow	10,560	1.9	Wilson clay loam	1,920	.3
Norfolk sandy loam	9,920	1.8	Orangeburg sandy loam	1,728	.3
Orangeburg fine sand	8,000	1.7	Miller fine sand	576	.1
Sanders loam	7,296	1.3	Total	545,000	.....
Susquehanna sandy loam	5,824	1.1			

NORFOLK FINE SAND.

The Norfolk fine sand consists of a gray to dark-gray, loose fine sand, underlain at a depth of 6 to 10 inches by a light-gray or pale-yellow incoherent fine sand. Usually a yellow, though sometimes

a red, fine sandy loam or clay is encountered at 3 to 20 feet. The soil of an occasional flat or nearly flat area is frequently compact and silty, while the subsoil is quite compact, silty, and tinged with yellow, in such places approaching the characteristic fine sand. In some of the higher elevations the soil is very incoherent and almost void of organic matter. The newly cleared land contains considerably more organic matter and has a darker color than that which has been under cultivation for several years. The absence of rocks and gravel, coupled with the open nature of the soil, makes cultivation easy over a broad range of moisture conditions.

The Norfolk fine sand occurs as the predominating type over a broad general belt having a northeast-southwest trend and roughly included between the "hard land" or prairie belt region in the southern part of the county and the mixed prairie and timbered land region lying to the north of Mud and Mineral creeks. Isolated areas are distributed throughout the uplands.

The topography of the Norfolk fine sand, in the main, varies from gently undulating to rolling with gentle slopes. There are many flat, comparatively small areas; but, on the other hand, a number of ridges and hills attain altitudes that mark them as topographic features of the surrounding country. While the loose-textured soil and subsoil permit excellent drainage by downward percolation, the type maintains a remarkably good supply of moisture. Good crops, even better than those of adjoining heavier soils, are produced in a droughty season. It is the latest soil in the area, particularly with respect to spring budding of vegetation. It is commonly termed "cold natured, deep sandy land." These apparent anomalies are undoubtedly due in part to natural mulching processes going on in the loose surface soil, which, together with the fine texture of soil and subsoil, tend toward conservation of moisture.

The type is sedimentary in origin and represents ancient beach deposits more or less influenced by partial submergence and by erosion. The native vegetation consists largely of black-jack oak. The more open and incoherent phase supports a dense, scrubby growth of black-jack and sand jack oaks, while some of the higher lying areas include small prairie spots with occasional clusters of sand jack and privet. There is always a scattering growth of hickory and post oak, these trees being especially in evidence on the flat, compact phase. About 75 per cent of the type is forested. Much of this is used for pasture, while the balance serves as open range for hogs and cattle. Hogs readily fatten on the mast when it is plentiful.

In the vicinity of Franklin the Norfolk fine sand is being used extensively for peaches and truck. Away from the railroad it is largely used for cotton and corn. It is an excellent truck soil, yielding from 80 to 150 bushels of early Irish potatoes with ordinary

management, and 100 bushels or more of tomatoes. Good crops of watermelons and sweet potatoes are made. The type is well suited to figs, plums, Kieffer pears, peaches, and small fruits, such as dewberries and blackberries. Good crops of sorghum and sugar cane are grown, particularly along streams. The luxuriant growth of wild grapes indicates its adaptation to grapes. Peanuts and cowpeas do well, affording excellent pasturage for hogs. Corn and cotton make fair average yields. In favorable seasons like that of 1906 the yield of cotton is as high as one-half bale per acre. In dry years corn does better on this than on the heavier types of soil. The silty, compact phase is best for cotton and corn, the moderately open soil for truck and fruit, while the loose, incoherent soil is rather an unproductive, leachy phase.

The type is generally deficient in organic matter.^a After a period of two to five years of maximum yields the soil begins to deteriorate in productiveness. A shallow surface loam worked up gradually by the frequent incorporation of organic matter, like well-rotted barnyard manure and green cowpeas, would improve the soil materially. In plowing, the best plan is not to go deep enough to turn to the surface any of the pale-yellow or light-colored subsoil, which seems to have a decidedly injurious effect upon soil productivity. This type suffered marked deterioration following the June flood of 1899, and is just beginning to regain its former productivity. This deterioration was undoubtedly due, in part at least, to leaching.

The Norfolk fine sand can be bought for about \$4 to \$15 an acre, according to location. Occasionally at some distance from the railroad the rent amounts to nearly as much as the land can be bought for.

^a The sample used in determining the manurial requirements of this type of soil was collected from a field 1 mile north of Franklin. The field has been in cotton for several years, no fertilizers of any kind having been applied. At the time the sample was taken the field had been planted to Irish potatoes and a commercial fertilizer applied at the rate of about 200 pounds per acre. The sample was collected from midway between the rows, and, therefore, had not yet become affected by the fertilizer.

Tests by the wire-basket method indicate that cowpea vines with lime or well-decomposed stable manure are about equally effective, and will produce a marked increase in the growth of plants on this soil. Of the commercial fertilizers used, a combination of nitrate of soda and sulphate of potash gave the largest increase in growth, but this increase was but little more than half as effective as the cowpea vines or manure. Nitrate of soda alone gave a fair increase in growth which was only slightly increased by the further addition of sulphate of potash. Lime, acid phosphate, and sulphate of potash used separately or in combination had no appreciable effect upon the growth of the plants.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Norfolk fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16575, 16577.....	Soil.....	0.1	0.6	4.7	69.1	17.6	6.1	2.0
16576, 16578.....	Subsoil.....	.1	.9	6.7	69.9	14.1	6.3	1.9

NORFOLK FINE SANDY LOAM.

The soil of the Norfolk fine sandy loam consists of a gray to dark-gray loamy fine sand to light fine sandy loam, underlain at 6 inches by a light-gray or pale-yellow material of about the same texture, which rests at 14 to 22 inches upon the true subsoil of bright-yellow sandy clay which sometimes is rather clammy.

The type is for the most part closely associated with the Norfolk fine sand. It generally occurs along slopes and stream courses and in depressions around the heads of streams. It maintains a favorable supply of moisture, crops rarely suffering from drought. Some of the depressed and flat areas could be improved by ditching.

The Norfolk fine sandy loam is derived from the same beach deposits that give rise to the Norfolk fine sand. The type is well suited to general farming. Yields of 400 to 1,200 pounds of seed cotton, 15 to 30 bushels of corn, and 200 to 500 gallons of sirup per acre can be secured. Sugar cane runs higher in sugar content, making more sirup than on the deep Norfolk fine sand. The average of the type would not be considered good fruit land, owing to the low position and lack of air drainage. Irish potatoes, sweet potatoes, melons, peanuts, and cowpeas do well. Oats would do fairly well sown in the fall. Organic matter should be added to the soil by turning under green cowpeas.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16581.....	Soil.....	0.1	0.1	0.4	32.8	49.1	13.2	3.4
16582.....	Subsoil.....	.2	.2	.4	26.2	32.9	15.0	24.7

NORFOLK SAND.

The soil of the Norfolk sand consists of a gray to dark-gray, loose and incoherent, medium to coarse sand, averaging about 12 inches in depth and carrying very little organic matter. The subsoil is a light-

gray, very incoherent, medium to coarse sand, generally resting upon a yellow sandy or gravelly sandy clay at a depth of about 3 or 4 feet.

Over half of the total area of this type occurs in the two large bodies touching the county line just east of Bremond. Isolated areas are found along the crest of the irregularly developed ridge to the north of Walnut Creek. Several widely separated bodies of a darker colored phase are found along the second bottom east of the Little Brazos River, the most important ones being west of Hearne and Calvert.

The upland phase is gently rolling, while that in the lower positions occurs as low ridges or nearly flat areas. Owing to the open structure water percolates through rapidly, and where the underlying clay is deeper than 3 feet this soil is inclined to be droughty and nonretentive of fertilizers, but not so much so as is generally the case with the Norfolk sand of other areas east of this region. Fair crops can be made in dry years with frequent shallow cultivation.

The upland phase represents reworked material of old beach deposits corresponding to but older than the Norfolk fine sand deposits. The body along the Little Brazos River was laid down in the early stages of the river when the flow was sluggish. The original timber growth is largely black-jack oak. The type is devoted largely to cotton, the yield being moderate but fairly certain. It is well suited to truck crops like tomatoes, watermelons, cantaloupes, Irish potatoes, and English peas. Sorghum does very well. It is believed that early strawberries could be grown successfully, and that grapes would find a favorable environment on this soil.

The Norfolk sand is badly in need of organic matter. It is considerably less productive than the average of the Norfolk fine sand. Although it is favorably located for trucking very little effort has been made in this direction.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Norfolk sand:

Mechanical analyses of Norfolk sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16585, 16587.....	Soil.....	2.8	14.5	22.4	40.2	10.1	7.2	2.2
16586, 16588.....	Subsoil.....	2.8	13.3	21.9	39.4	11.2	7.8	3.4

NORFOLK SANDY LOAM.

The soil of the Norfolk sandy loam, to a depth of 12 to 22 inches, consists of a gray loamy sand or a very light medium sandy loam. The subsoil is a bright-yellow heavy sandy loam to sandy clay, underlain by a sandy or gravelly clay, generally yellow, but occasionally red in color.

The type is confined principally to the slope and high land along the northern side of Walnut Creek. There are several isolated areas of a more loamy character near the brink of the slope to the Brazos bottoms.

The topography varies from nearly flat to gently rolling. The Norfolk sandy loam maintains a more favorable supply of moisture than the Norfolk sand, and is more retentive of organic matter.

The Norfolk sandy loam consists of sedimentary material, which since its emergence has been considerably influenced by the washing out of the finer particles by rain. The yellow color of the subsoil undoubtedly is due in part to lack of subsoil drainage and aeration.

At present the type is used largely for cotton and corn, the yields being moderate, although better than on the Norfolk sand. Some good yields of early Irish potatoes have been made in the vicinity of Calvert. The soil is well suited to vegetables, particularly Irish and sweet potatoes, sweet corn, melons, cucumbers, and garden peas. Peaches, pears, figs, grapes, and small berries would do well.

For best results, considerable organic matter, like stable manure and green cowpeas, should be incorporated in the soil at frequent intervals.

The Norfolk sandy loam situated favorably with reference to shipping points can be secured at a very reasonable price.

The following table gives the average results of mechanical analyses of samples of soil and subsoil of the Norfolk sandy loam:

Mechanical analyses of Norfolk sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16589, 16591.....	Soil.....	0.4	9.9	12.8	45.1	9.6	17.4	4.2
16590, 16592.....	Subsoil.....	.8	9.9	12.0	35.2	5.7	18.8	17.6

ORANGEBURG SAND.

The Orangeburg sand is confined principally to a narrow strip following the low bluff line of the Brazos bottom and the slopes along the lower course of Walnut Creek. The soil consists of a reddish-brown medium sand underlain at 15 to 24 inches by a red sandy clay, which is rather stiffer than the subsoil of the average Orangeburg sand.

Owing to its situation the Orangeburg sand is not very important agriculturally and the yields are rather low. About one-fourth bale of cotton is a fair yield per acre under present methods of treatment. Additions of organic matter would result in increased yields. Some of it is well suited to Irish potatoes and truck.

The character of this type has been influenced by its position. Rains have washed out the finer soil particles, while good drainage has induced a favorable subsoil structure through better aeration and oxidation. It is apparent from the close association with other types that the Orangeburg sand has not been derived altogether from the same material as the more typical Orangeburg soils like the Orangeburg fine sandy loam.

The following table gives the results of mechanical analyses of the soil and subsoil of the Orangeburg sand:

Mechanical analyses of Orangeburg sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16595.....	Soil.....	0.9	10.4	20.0	31.8	9.6	22.5	4.8
16596.....	Subsoil.....	.4	9.2	16.5	28.3	7.3	22.2	15.4

ORANGEBURG SANDY LOAM.

The Orangeburg sandy loam is a dark-brown sandy loam underlain at an average depth of 10 inches by a brick-red friable sandy clay.

The type is very limited in extent, occurring in small, widely separated areas in second bottom along the Little Brazos or as low, narrow ridges in the Brazos bottoms. The character of the soil has been considerably influenced by the waters of the Brazos rivers, particularly in bringing about the dark color. The low patches in the bottom represent remnants of the older upland sedimentary material, as is evidenced by that body occurring in the small mound-like elevation at Mumford. This eminence, though surrounded by and lying only about 20 feet above the river alluvium, is plainly a remnant of the uplands which withstood stream erosion.

The Orangeburg sandy loam is quite a productive soil, producing good yields of cotton, corn, and Irish potatoes.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Orangeburg sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16601.....	Soil.....	0.3	9.2	14.7	35.1	15.5	22.1	3.7
16602.....	Subsoil.....	.1	6.8	11.5	20.6	10.1	26.9	24.2

ORANGEBURG FINE SAND.

The Orangeburg fine sand consists of a dark-gray to reddish-brown fine sand, increasing in redness with depth and passing into a red sticky sand, sandy loam, or sandy clay at 18 to 36 inches. Generally iron concretions and iron sandstone fragments are scattered over the surface and disseminated throughout the soil, especially on knolls and near stream bluff lines.

The type occurs in detached areas, generally as knolls or as narrow strips along streams. There are some quite rocky areas along Mud, Cedar, Mineral, and Duck creeks. A rather hilly or broken area borders the Navasota bottom just south of the point where Steele Creek enters the bottom land. Here the soil is deep in the small valleys while on the crests of hills it is shallow and rocky.

Only a small percentage of the type is under cultivation. The yields of general farm crops are moderate. It seems best suited to fruit and truck farming. Much of the type is rather inconveniently situated for farming.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Orangeburg fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16597, 16599.....	Soil.....	0.3	1.1	4.9	47.9	23.3	16.3	6.0
16598, 16600.....	Subsoil.....	.3	1.1	3.5	38.8	24.9	15.4	15.5

ORANGEBURG FINE SANDY LOAM.

The soil of the Orangeburg fine sandy loam consists of 5 to 15 inches of dark-gray, reddish-brown, or red fine sandy loam varying in texture from light to heavy. Generally a small quantity of iron sandstone gravel occurs in the upper portion of the soil. The small rounded knolls and narrow ridges are nearly always very gravelly in the surface 10 inches. Fragments and large boulderlike pieces of reddish and yellowish iron sandstone are scattered over the surface of many of the higher areas. This rock is generally conglomeritic, consisting of ferruginous and occasionally quartz pebbles cemented in a sandy matrix by iron oxide.

The subsoil is a pale-red to deep-red sandy clay, moderately friable in the upper portion and becoming stiffer and heavier with increasing depth. Irregularly developed, yellow, iron oxide hardpans and concretions may be found occasionally anywhere in the subsoil profile. The subsoil is generally less friable than the average for the Orangeburg fine sandy loam.

The type is locally termed "red land." It occurs in two roughly parallel, nearly continuous belts crossing the county in a northeast-southwest direction. The one beginning east of the Little Flock neighborhood passes through the Henry Prairie and Black Jack sections; the other skirts along the prairie belt in the southern part of the county. There are a number of isolated areas appearing as knolls, ridges, and slopes throughout the deep sandy region of the southern half of the county. The topography is such as to afford good surface drainage without danger of erosion. The underdrainage is good. The soil is not crusty and crops are not as subject to drought as is the case with the other "hard lands."

Geologically, the Orangeburg fine sandy loam represents marine sediments laid down probably in Eocene time. The knolls and ridges are a part of a series of iron ore or ferruginous-capped hills that stretch from the Louisiana line nearly across the State from northeast to south-central Texas. There are evidences going to show that the conglomeritic iron sandstone so closely associated with this type has been derived from the underlying clays by processes of weathering mainly through cementation by precipitation and oxidation of iron salts carried into the mass in solution.

The timber growth is mainly post oak and hickory. A large proportion of the better lying land has been put under cultivation. The Orangeburg fine sandy loam is the most productive of the upland soils. The heavy red phase, like that in the Little Flock and Henry Prairie neighborhoods, produces from one-half to 1 bale of cotton and usually from 25 to 40 bushels of corn per acre. Peaches probably do best on this soil. Pears, plums, figs, blackberries, dewberries, and strawberries also do well. From 100 to 150 bushels of early Irish potatoes, over 100 bushels of tomatoes, and fine crops of sweet potatoes and melons can easily be obtained. This is the soil on which a fine quality of cigar tobacco has been grown in eastern Texas. The soil is early, durable, and quite responsive to cultivation.

The Orangeburg fine sandy loam can be bought for from \$5 to \$15 an acre, according to locality. Some well-kept farms are held at a higher price.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16606, 16607.....	Soil.....	0.2	1.6	1.8	36.6	17.0	35.6	7.5
16606, 16608.....	Subsoil.....	1.5	1.8	1.1	14.9	14.9	38.5	27.3

ORANGEBURG GRAVELLY SANDY LOAM.

The Orangeburg gravelly sandy loam, though of limited extent, is an important type, owing to its earliness and its adaptability to vegetables.

The greater part of this type occurs in the vicinity of Hearne, occupying the slopes of the country east and north of the town and the bluff lines of Big and Little Pin Oak creeks and the Brazos bottom escarpment. Several small areas—low hills and ridges—occur around Franklin. The soil is a reddish-brown material, composed of iron oxide sand and iron-stained quartz sand, carrying from 15 to 40 per cent of iron concretions and quartz gravel in the surface 10 inches. The soil depth is quite variable, frequently changing from a few inches along the upper slopes to 20 or more inches in the lower positions. Rocks are sometimes found near the bluff lines.

The type is derived largely from the same material as that giving rise to the Orangeburg fine sandy loam. That in the neighborhood of Hearne has been more subjected to denudation and may be the remnant of a coarser deposit over the material corresponding to that in the neighborhood of Franklin.

The Orangeburg gravelly sandy loam offers good opportunities for the production of early vegetables, like English peas, tomatoes, corn, and beans. It is a rather inferior soil for general farming. It is held at very moderate prices.

The following table gives the results of mechanical analyses of a fine-earth sample of the soil and subsoil of the Orangeburg gravelly sandy loam:

Mechanical analyses of Orangeburg gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16593.....	Soil.....	5.0	3.6	1.6	33.0	19.6	31.7	5.2
16594.....	Subsoil.....	1.0	1.0	.5	20.5	15.0	26.9	35.4

SUSQUEHANNA FINE SANDY LOAM.

The soil of the Susquehanna fine sandy loam consists of a light-brown to dark-brown fine sandy loam, averaging about 10 inches in depth. While generally the soil depth is quite uniform, there are some places where the soil may change suddenly within a distance of a foot or two from a few inches to 2 feet in depth.

The subsoil is a stiff plastic clay, either red or red mottled with drab or yellowish-brown, the color generally changing in the lower portion to a mottled red and gray or yellow and drab. Frequently the subsoil at about the depth of 3 feet contains more sand than the

overlying material. The line of demarcation between soil and subsoil is very distinct. The varying depth of the soil sometimes shows peculiar regularity in the rise and fall of this line of separation, as exposed in cuts. Here and there lime concretions are seen in the yellow substratum exposed in "dugouts" and road cuts. Analysis shows the soil and subsoil to contain inappreciable quantities of lime, indicating the probable need of applications of lime now and then, particularly in conjunction with the turning down of green manures or other vegetable matter.

The type is generally free from stones, but occasionally iron concretions and fragments of iron sandstone are scattered over the surface of small areas. In the prairies there is an occasional small black spot around the head of a drain.

The type embraces both timbered and prairie land. The soil of the prairie land is generally darker colored, while the subsoil is more mottled. The soil tends to assume a crusty and compact structure after rains, necessitating prompt cultivation in order to conserve moisture. A favorable tilth can be maintained easily with timely cultivation.

The Susquehanna fine sandy loam is the most extensive and important type, embracing about 26 per cent of the total area of the county. It occupies the greater part of the northern half or that part of the county lying north of Mud and Mineral creeks. Other important areas occur throughout the uplands. There is a long, narrow, valleylike, nearly flat belt, extending from near Hearne eastward, following the route of the International and Great Northern Railroad. The topography varies from nearly flat along the railroad to the rolling land or gently sloping prairies of the northern part of the county. There are a few commanding points, like that near Nesbitt, from which a view of the surrounding country can be had. The numerous "dugouts" and branches insure good surface drainage to a large part of the type. The prairies are particularly well drained. Owing to the tendency to assume a close, compact structure the soil is inclined to be droughty. Corn is apt to suffer from this cause, especially in the absence of good seasons in June and July.

The type is derived from the underlying sedimentary clays which were laid down in comparatively deep water during the lignitic stage of the Eocene-Tertiary. The timber growth is mainly post oak, and generally the heavier the post oak growth the better the soil. The black spots of the prairie originally supported a growth of mesquite.

The Susquehanna fine sandy loam is a productive soil and very desirable. Though adapted to a large number of crops, it is almost entirely devoted to cotton and corn. In an average season, with fair cultivation, it produces from one-third to one-half bale of cotton. With proper treatment a bale to the acre can be grown. The ordi-

nary yields of 10 to 20 bushels of corn may be increased to 30 or 40 bushels in exceptionally favorable years. The best crops are made by breaking the land early to a depth of 8 to 10 inches, planting early, and giving frequent shallow cultivation. Fair yields of oats are made when sown in the fall on thoroughly prepared land. The crop this year (1907) was almost entirely ruined by drought. From 10 to 20 bushels of wheat per acre have been produced, but none is grown at present. Although yields of grain have been small when the crops were consecutively grown, this undoubtedly would be remedied if grain were rotated with cotton, corn, and cowpeas.

The Susquehanna fine sandy loam does not seem so well suited to peaches as the character of the surface soil and the topography would indicate. This may be attributed to the stiff plastic clay subsoil, which is not favorable to the peach tree anywhere. The trees frequently die at the age of about 5 years, but this tendency is not so prevalent with seedlings. It would not be advisable to put in large orchards without a thorough test of varieties and cultural methods. Figs, plums, Kieffer pears, and berries do well. Irish potatoes are of good quality and make good yields where the land is manured and carefully handled. Generally the late summer and fall are too dry or the rainfall too irregularly distributed for good late crops. Sweet potatoes, beets, cabbage, onions, beans, sorghum, and peanuts do well.

The type is considered fairly early. Cotton is planted a little later than in the Brazos bottom, but usually earlier than on the Norfolk fine sand. The soil is very durable. Some of it has been under cultivation continuously thirty or forty years without fertilizers and with little attention to rotation and is still producing moderate crops. However, much of the type has been badly run down.^a Such worn fields are susceptible of rapid improvement by growing cowpeas in rotation with cotton and corn or by applications of barnyard manure. The plowing under of an occasional crop of green cowpeas in conjunction

^a Tests to determine the manurial requirements of this soil were made in the Bureau laboratory. Two samples were collected for this purpose. One was taken from a field 3 miles southeast of Bald Prairie, and represents the timbered phase of this soil. The other was taken from a field near Bald Prairie, and represents the prairie phase of this soil. Aside from the native vegetation, there is practically no difference in the appearance or character of the soil from these two fields. The field near Bald Prairie has been in cultivation since 1864. No fertilizers have ever been used on the field until the present year (1907), and the sample was collected from that portion of the field which had not yet been treated. Cotton and corn have been the principal crops grown, and the average yield has been about 12½ to 15 bushels per acre for corn and one-third of a bale per acre for cotton. No noticeable decrease in yield has been observed during the past few years.

The other field, representing the prairie phase of this soil, has been in cultivation for about thirty years, usually to corn or cotton. No fertilizers have ever been used on this field until the present year (1907), when commercial fertilizer was applied

with an application of 50 bushels of lime an acre would help to bring the type into prime condition. Deep, flat breaking in the fall would conserve the winter rains and insure better tilth. The subsoil is generally too deep to be reached by plows ordinarily used, but wherever it is possible a thin layer turned to the surface in the fall would improve the texture. Shallow breaking tends to hasten development of crops, but intensifies susceptibility to drought. Commercial fertilizers are coming into use. Applications of complete brands costing from \$15 to \$20 a ton at the rate of 200 pounds an acre have been profitably used for cotton. Cotton seed and barnyard manure are very effective. Farmers on this type generally have good homes and make a comfortable living. The land can be bought for about \$10 to \$15 an acre. Some improved farms near towns are held at considerably higher figures. Some prefer this to the Brazos bottom land.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Susquehanna fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16615, 16617.....	Soil.....	0.7	0.5	1.2	21.7	35.3	28.9	11.5
16616, 16618.....	Subsoil.....	.1	.3	.4	9.7	22.4	23.7	42.6

SUSQUEHANNA SANDY LOAM.

The soil of the Susquehanna sandy loam to a depth of 12 to 20 inches consists of a gray, open, light sandy loam carrying little organic matter. The subsoil is a red stiff clay mottled in the lower portion with yellow and gray. The content of coarse and medium sand makes the soil seem to have a lighter texture than is really the case, and imparts a

at the rate of about 200 pounds per acre in an experimental way, three different brands being used.

Cowpea vines with lime gave a marked increase in growth of plants on both of these soils, and in each case the next largest increase was produced by a combination of nitrate of soda and sulphate of potash.

Barnyard manure gave a good increase in growth for the timbered phase but a rather small increase for the prairie phase, while lime gave a good increase on the prairie phase but no appreciable increase on the other. On neither of these soils would acid phosphate or sulphate of potash used separately or in combination produce any appreciable increase in growth. These results are based on the relative growth of wheat plants covering a period of about twenty-five days, and it is probable that the phosphate would increase plant growth if plants were carried to maturity.

These results, while strictly applicable only to the field from which the samples were obtained, and for wheat or similar crops, will probably be found to apply generally to this type of soil throughout the area.

slight brittleness to the subsoil. The soil of the flat areas has a higher content of fine sand and usually is quite compact.

Susquehanna sandy loam occurs as a few irregular bodies in the belt of coarse sands along the ridge between Walnut Creek and Bremond, in the northwestern part of the county. While a little of the type occupies nearly flat or gently rolling stretches in the high elevations, the greater part is found along the gentle slopes reaching down to the streams. The drainage is good. The timber growth varies from a mixture of post and black-jack oak on the shallow soil of the slopes to scrubby black-jack on the deep sandy soil of the nearly flat areas.

The type is considerably less productive than the Susquehanna fine sandy loam. Moderate yields of cotton and corn are the rule. Good truck crops could be grown.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Susquehanna sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16613.....	Soil.....	5.1	13.6	4.5	43.9	11.3	17.6	3.9
16614.....	Subsoil.....	.2	1.4	1.0	23.9	3.5	21.4	48.0

SUSQUEHANNA LOAM.

The Susquehanna loam to a depth of about 6 inches is a dark-brown loam to clay loam, underlain by stiff, plastic, mottled clay subsoil nearly identical with that of the Susquehanna fine sandy loam.

The type occurs in the higher elevations of the prairie, always associated with the Susquehanna fine sandy loam, and represents areas from which the sandy soil material has been partially removed by erosion or where the original sedimentary clays have not undergone deep weathering.

This is an excellent cotton soil and makes a good yield of oats. It is a little droughty for corn and is not especially suited for general trucking. Onions and cabbage would do well.

The results of mechanical analyses of this type of soil are given in the following table:

Mechanical analyses of Susquehanna loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16623.....	Soil.....	0.0	0.2	0.5	12.7	30.7	33.8	21.5
16624.....	Subsoil.....	.1	.3	.3	7.9	23.5	32.7	34.2

LUFKIN FINE SANDY LOAM.

The soil of the Lufkin fine sandy loam consists of a dark-gray compact fine sandy loam, frequently becoming light gray in color and quite silty below the immediate surface soil. At 8 to 15 inches a stiff, very plastic and impervious dull-yellow clay, sometimes mottled with red, occurs, which generally becomes mottled yellow and gray with increased depth. In the poorer drained places the subsoil may be an extremely stiff, very dark or ashy-gray clay. When moist this clay rubs out between the fingers like soap. When exposed to the sun it shrinks and cracks somewhat like jointed clay. Occasionally a small quantity of gravel or lime concretions is disseminated throughout the subsoil. The line of separation between soil and subsoil is sharply defined, there never being a blending of the one with the other. Owing to the sandy nature of the soil, cultivation is easy. The type is locally termed "hard post-oak land."

The Lufkin fine sandy loam occurs throughout the uplands. There are two notably large bodies, one lying between Campbell and Spring creeks in the southwestern part, and the other contiguous to the Navasota bottom in the northeastern part of the county. The surface configuration of the type is largely flat or only slightly rolling. Frequently small well-drained areas are encountered in depressions around the heads of "dugouts" and streams. Many of these were too small to indicate on the map.

Drainage of the flat areas is sometimes so poor that during wet seasons water stands in pools on the surface. In seasons of normal rainfall the drainage is good in spite of the impervious subsoil. This is largely due to a well-distributed system of natural drainage ways—streams and gullies or "dugouts." These "dugouts," once started, encroach rapidly upon the nearly flat areas, following up slight depressions or natural drainage ways. Several bodies of an acre or more have been rendered unfit for cultivation through the dissection of the land by "dugouts." Some of the flat areas need open ditches to carry off excessive surface water. Because of the hard, compact structure of the soil in dry weather much moisture is lost by surface evaporation through the action of capillarity, and crops are likely to suffer unless the capillary connection with the surface is destroyed by mulching.

The Lufkin fine sandy loam is derived from Eocene deposits which, owing to comparatively poor drainage, have not been influenced materially by weathering below 8 to 15 inches. A large proportion of the type is forested mainly with a rather sparse growth of heavy post oak and hickory. The growth is quite scattering in places, giving rise to the term "glady land." In favorable seasons good yields of cotton and corn are secured with timely cultivation. Owing to the small acreage under cultivation and the rather indifferent

treatment, it is difficult to estimate yields, though it is claimed that one-half bale of cotton is a fair average. Corn suffers from drought and yields indifferently well. Some good peaches were seen on slight elevations having good natural drainage. The flat stretches are not especially suited to fruit. Sweet potatoes and ribbon cane do well. Irish potatoes find a rather unfavorable environment, except where the surface soil is 1 foot or more in depth. Cowpeas and peanuts can be grown successfully in connection with hog raising. Vegetable matter, like peavines, turned under green or matured, in late summer or early fall at intervals of three to five years, would be beneficial to this soil, especially if accompanied by the addition of about 50 bushels of lime an acre. The content of lime is very low.

The Lufkin fine sandy loam is improved by early plowing, especially where a thin layer of the subsoil is turned to the surface in the fall. Frequent shallow cultivation is essential to the most successful results. The Lufkin fine sandy loam is a better soil than its present undeveloped condition would indicate. It can be bought at about \$5 to \$12 an acre.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Lufkin fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16555, 16557.....	Soil.....	0.1	0.5	0.9	33.3	17.7	41.8	5.9
16556, 16558.....	Subsoil.....	.1	.3	.5	12.9	8.4	27.6	50.2

LUFKIN CLAY.

The Lufkin clay occurs in small, flat, low-lying areas always near the head of a stream or "dugout." As it has no timber growth or supports only a scattering growth this land is locally termed prairie or "glady land." Serving as a catch-basin for material washed down from the surrounding slopes, the surface soil is quite variable in texture. A few inches of the surface material may be a very fine sandy loam, a silt loam, or silty clay; but it is always very compact and nearly black in color. The subsoil is a black, stiff, very impervious clay, which sometimes in the lower portion becomes ashy gray or ashy gray mottled with dull red. The black subsoil generally has an ashy-gray cast upon drying out.

The general appearance of the type suggests an unproductive, unyieldy soil, and but little of it is under cultivation. Its structure is very unfavorable to drainage, aeration, and tillage. It is limited in acreage. Several areas were too small to represent on the map. The soil could be improved by artificial drainage. Some fair crops

of cotton and corn and good Johnson grass have been made on spots where the drainage has improved by the intrusion of "dugouts."

The Lufkin clay represents either marine deposits which, after being laid down concurrently with the Lufkin fine sandy loam, have undergone only slight weathering or been modified by accumulations of fine material washed into depressions.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Lufkin clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16559.....	Soil.....	0.0	0.9	0.7	8.9	7.7	55.5	26.6
16560.....	Subsoil.....	.2	.4	.7	9.6	7.6	42.5	39.2

LUPKIN FINE SAND.

The Lufkin fine sand to an average depth of about 26 inches consists of a compact, light-gray, very fine sand, which is slightly loamy, owing to the presence of a considerable percentage of silt. The subsoil is a very compact, yellowish gray, fine silty sand, sometimes slightly mottled yellow and reddish. When dry, the subsoil is extremely compact and hard to bore into with the soil auger.

The Lufkin fine sand occurs in small, widely separated areas. A considerable number of very small areas had to be included with the Norfolk fine sand on account of size and irregular occurrence.

In surface configuration it conforms to the characteristic features of the other Lufkin types. The timber growth is heavy post oak, hickory, and black-jack. Its agricultural value with respect to the production of cotton and corn is better than that of the Norfolk fine sand and nearly the same as that of the Lufkin fine sandy loam. It is especially suited to sweet and Irish potatoes, sugar cane, melons, peanuts, and beans.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Lufkin fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16553.....	Soil.....	0.0	0.1	0.3	48.2	24.8	22.0	5.0
16554.....	Subsoil.....	.1	.1	.2	50.4	11.4	27.6	10.7

CROCKETT CLAY LOAM.

The greater part of the soil of the Crockett clay loam is an almost black, silty clay loam, averaging about 15 inches in depth. Some small areas contain considerable quantities of iron concretions in the upper

soil portion. The subsoil is generally a clay loam, which quickly passes into a stiff clay, sometimes carrying a small quantity of iron and lime concretions. The subsoil is extremely variable in color, frequently changing from black to yellow then to black again within the distance of a few feet, as in the case of the "hog wallow" phase. The predominating color is a dark red, passing into a bright red mottled with greenish drab or yellow. The subsoil of the black spots may be nearly black to a depth of 3 feet.

The "hog wallow" phase embraces areas whose surface is made slightly uneven by small rounded hummocks or mounds a few feet in diameter and about 4 to 8 inches higher than the intervening depressions. The soil in the depression is a deep black clay loam, underlain by yellow or reddish clay, while on the mounds it is a stiff yellow clay and generally gravelly. The subsoil always passes either into a red, yellow, or a mottling of one of these from 3 to about 6 feet. Notwithstanding lime concretions and fossil shells, which are encountered in the deep subsoil exposures, the lime content of both soil and subsoil is low. The "hog wallow" phase and excessively gravelly spots are unyieldy and difficult to manage, especially in dry weather. With these exceptions the type is easy to cultivate under proper moisture conditions.

The Crockett clay loam comprises the larger part of the strip of prairie crossing the upland part of the county along the southern boundary. This strip averages about 2 miles in width and is 22 miles long. Here three other bodies of about one-half square mile each occur—two just south of Henry Prairie and the other $5\frac{1}{2}$ miles east of Franklin on the Eaton Road. The lay of the land is gently rolling. Both surface and underground drainage are good. The type is inclined to suffer from drought unless given frequent timely cultivation.

The Crockett clay loam is derived, at least in part, from the impure underlying fossiliferous limestone, and probably also in part from sedimentary clays, similar to those giving rise to the Susquehanna fine sandy loam laid down over the limestone formation. The type appears to have a relationship to both the Susquehanna and Houston series, and it is probably a transitional type between the two.

Though originally prairie, some mesquite and prickly ash grow on it. It produces excellent wild hay, principally sedge grasses. Bitter weed is very common. A large proportion of the type is used for pasture and hay land. It is adapted to general farming, producing from one-third to three-fourths bale of cotton, 20 to 50 bushels of corn, and 25 to 40 bushels of oats per acre. The "hog wallow" and gravelly phases give only average yields. The black spots are the most productive. Fair crops of wheat could be grown. It is claimed that alfalfa does not do well, but the poor yield is probably

due, in part at least, to smothering by the rapid growing grasses and weeds. It is considered a good pear but poor peach soil. The Kieffer pear resists blight best and seems to find a better environment than other varieties tried. Sorghum does well and generally much better than cane.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Crockett clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16549.....	Soil.....	1.7	1.9	1.1	17.7	13.4	39.8	24.0
16550.....	Subsoil.....	1.4	1.6	.9	16.8	12.5	39.1	27.1

CROCKETT FINE SANDY LOAM.

The soil of the Crockett fine sandy loam is a dark-brown to nearly black heavy fine sandy loam from 6 to 12 inches deep. Some small areas on the higher elevations are quite gravelly. The subsoil is a loam passing into a stiff clay loam and is generally of a mottled red or yellow color, frequently containing concretionary iron gravel.

The Crockett fine sandy loam occurs as gently rolling prairie land. The drainage is good. Some of that on the border of the timbered land supports a sparse growth of post oak. The soil is adapted to about the same crops as the Crockett clay loam. It is a particularly good soil for oats and corn. Irish potatoes, peas, and small berries would do well on those spots having a deep loamy soil.

The following table gives the results of mechanical analyses of the fine earth of the soil and subsoil of this type:

Mechanical analyses of Crockett fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16547.....	Soil.....	1.4	2.2	1.1	29.9	19.2	34.9	11.7
16548.....	Subsoil.....	1.9	.9	.8	19.0	18.1	39.5	20.0

CROCKETT GRAVELLY LOAM.

The soil of the Crockett gravelly loam is a yellowish-brown fine sandy loam to loam carrying from 15 to 60 per cent of quartz and iron sandstone gravel in or immediately under the surface soil. The high gravel content just beneath the surface makes that portion resemble a gravel hardpan. Below 8 inches there is very little gravel. The

subsoil is a very stiff, plastic, slightly sandy clay containing some gravel and occasionally lime concretions. The subsoil is quite variable in color but usually yellow with a greenish tinge. In small areas it may be bright yellow, deep red, or black.

The type is derived from the underlying clays and fossiliferous sandstone which probably belong to the lower division of the Quaternary. The Crockett gravelly loam occurs in the vicinity of Sutton in one body of about 5 square miles. The land is gently rolling, well drained, and sparsely timbered with post oak. Very little is under cultivation. A small part is too gravelly for economical cultivation. It is one of the earliest soils of the area. The foliage of trees on this and the Orangeburg gravelly sandy loam is always so well ahead of that on other types as to offer a striking contrast in the appearance of the timber in the spring. Early truck crops, like garden peas, tomatoes, and lettuce could be grown successfully. English peas, radishes, blackberries, and dewberries would do well.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Crockett gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16625.....	Soil.....	1.8	3.9	5.3	29.9	22.1	21.8	16.0
16626.....	Subsoil.....	2.3	2.4	3.7	17.1	13.1	21.4	39.2

WILSON CLAY LOAM.

The Wilson clay loam is a black heavy clay loam underlain at about 6 inches by a black, extremely stiff and tenacious clay. There are three important areas in the vicinity of Calvert and two others west of Hammond. These occupy the flat land resembling second bottoms, which borders the Brazos bottom. The topography here indicates that the upland was more or less graded down by overflows from the river in its earlier stage of development. The soil material, except perhaps the shallow mantle, belongs to the sedimentary upland.

The origin of the type is not well understood, though the thick growth of mesquite and grass undoubtedly had much to do with imparting the dark color. The type is locally termed "mesquite flats." Very little is under cultivation. The surface drainage is poor on account of the flat surface configuration. The soil assumes a hard, intractable structure in dry weather, making cultivation very difficult and causing crops to suffer from drought. Corn and cotton do well with favorable seasons.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Wilson clay loam:

Mechanical analyses of Wilson clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16543.....	Soil.....	0.1	1.0	2.1	11.7	12.6	47.0	26.0
16544.....	Subsoil.....	.3	.9	2.0	11.5	13.9	41.7	29.8

WILSON FINE SANDY LOAM.

The Wilson fine sandy loam to a depth of 7 to 15 inches consists of a dark-gray to nearly black fine sandy loam, underlain by a nearly black clay loam which becomes very stiff in the lower portion.

The type occurs as small areas in the high prairies of the northern part of the county and on the second-bottomlike flat land bordering the Brazos bottom where it is closely associated with Wilson clay loam. There are several square miles of the type in the vicinity of Calvert.

The surface of the Wilson fine sandy loam is quite flat and, like the Wilson clay loam, originally supported a growth of mesquite. Practically all of it is under cultivation to corn or cotton. It is considered an early soil, but is susceptible to drought and restricted to a rather narrow range of moisture conditions, suited to easy, effective cultivation. If allowed to stand too long after rains it becomes crusty and hard to manage. For best results deep and early breaking and frequent shallow cultivation are required.

The type is adapted to cotton, yielding from one-fourth to one-half bale per acre, according to the season and intensity of cultivation. Corn makes a rapid growth, but is considered uncertain on account of June and July droughts.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Wilson fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16539, 16541.....	Soil.....	0.0	2.3	4.3	23.8	25.7	38.9	6.2
16540, 16542.....	Subsoil.....	.3	1.7	2.5	12.2	14.7	38.8	29.9

SANDERS LOAM.

The Sanders loam is a dark-gray to nearly black loam to fine sandy loam, 12 to 24 inches deep, overlying a dark-brown loam to silty fine sandy loam. In places the texture is quite variable, changing in short

distances from recently deposited loamy fine sand to silt loam. Where the contiguous uplands are quite sandy the lighter material has been washed down and spread over the true alluvium, giving the soil the appearance of a deep, dark-gray sandy loam. This washing down of sandy material not infrequently depreciates the value of the type.

The Sanders loam is confined largely to the upper courses of the large creeks, like Walnut, Mineral, and Duck. It supports a growth of pin oak, pecan, post oak, ash, cottonwood, elm, and hackberry, with an occasional sprinkling of walnut. Although subject to overflow, the soil is very desirable. It produces from 40 to 75 bushels of corn per acre, and cotton and grass do well. Yields of 200 to over 400 gallons of sirup an acre are easily made.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Sanders loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16635.....	Soil.....	0.1	2.1	6.8	19.9	12.5	46.9	12.0
16636.....	Subsoil.....	.1	2.5	7.2	19.4	9.7	45.8	15.0

SANDERS SILT LOAM.

The Sanders silt loam to an average depth of 12 inches is a dark-colored or nearly black, heavy, compact silt loam. There is frequently a mottling of brown and drab immediately beneath the surface soil. Pockets of sand may occur anywhere in the soil profile or a mantle of sandy material may cover small areas. Though the subsoil is variable in texture and color, it is generally a dark-gray or brown mottled with drab silt loam, passing into a brown fine sandy loam in the lower portion.

The Sanders silt loam is an alluvial soil and occupies the bottom lands along the lower courses of a number of creeks. The most extensive areas are those along Walnut, Duck, and Mineral creeks. The native timber comprises pin oak, ash, pecan, hackberry, elm, cottonwood, and some scattering walnut, boxelder, and holly.

The type is subject to overflow, but frequently good crops are made. It is the strongest corn soil of the area, producing from 45 to 75 bushels per acre without fertilizers. Cotton also does well. Johnson and Bermuda grass yield three heavy cuttings of excellent hay. Heavy yields of sirup are obtained. The soil is remarkably strong and durable, needing no kind of fertilizers. This land can be bought at a very reasonable price.

The average results of mechanical analyses of samples of the soil and subsoil of the Sanders silt loam are shown in the following table:

Mechanical analyses of Sanders silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16631, 16633.....	Soil.....	0.1	0.5	0.5	6.8	6.0	60.6	24.9
16632, 16634.....	Subsoil.....	.0	.1	.3	18.3	5.4	50.4	24.8

WABASH CLAY.

The Wabash clay is a dark-drab to black stiff clay underlain at a depth of 4 to 8 inches by an extremely stiff, compact, nearly black or dark-brown clay mottled with drab. Occasionally, where the surface is hummocky, the subsoil is drab or dark gray and may be exposed on the surface of the hummocks. The soil becomes extremely sticky when wet.

The Wabash clay occurs largely in the bottom land of the Navasota River and Steele Creek. The strip along the Navasota varies from a few rods to over a mile in width, averaging nearly a mile. There is a considerable area in the lower Brazos bottom at the mouth of Campbell Creek and several smaller areas elsewhere in the bottom lands of the Brazos. The surface is flat or broken only by the channels of tributaries and old stream beds or sloughs. There are several shallow lakes in the Navasota bottom. The soil consists of fine dark-colored material deposited from overflow waters. Derived largely from the black lands along the upper courses of the Navasota and its tributaries, the material of the Wabash clay offers an interesting contrast with the red colored Miller clay of the Brazos River—a soil derived from the Permian Red Bed region of its upper courses. The stiff, unyieldy nature of this soil, as compared with the tractable Miller clay, is due to a very much lower lime content. The organic matter content is about the same as that of the Miller clay, being 2.31 per cent for the soil and 2.29 per cent for the subsoil. With the exception of an occasional glade or small “prairie,” like that at Graysons Crossing, the entire Navasota and Steele Creek bottoms are heavily timbered with pin oak, post oak, elm, hackberry, and a scattering of holly and hickory.

On account of frequent overflows none of the type, except narrow strips along the outer edge and the areas in the Brazos bottom, is cultivated. The soil is very productive, sometimes producing a bale of cotton and from 30 to 75 bushels of corn per acre.

The Navasota bottom can be successfully cultivated only through the construction of dikes and levees. This would be an immense undertaking on account of the necessity of diking the creeks and

small streams that enter the river. It is probable that ditches would have to be dug along the outer margin to protect against flow off from the uplands. Small areas might be managed by surrounding them with dikes run out from the base of the bluff line without any great outlay of money. In view of the abundance of good upland that can be had at remarkably cheap prices it would seem doubtful policy for an individual alone to undertake the reclamation of any extensive area of this bottom land at present. The reclamation of this overflowed land, however, offers an opportunity for local, State, and Federal cooperation.

Much of this land can be bought for \$3 to \$10 an acre. It affords good pasturage for cattle and hogs and the timber is valuable.

The following table gives the results of the mechanical analyses of the soil and subsoil of the Wabash clay:

Mechanical analyses of Wabash clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16139.....	Soil.....	0.1	1.3	1.5	14.5	15.8	35.7	31.0
16140.....	Subsoil.....	.0	.3	.8	9.5	11.7	30.3	46.7

MILLER CLAY.

The soil of the Miller clay consists of a chocolate to chocolate-red heavy clay from 5 to 10 inches deep. Upon drying out after rains the soil breaks into small aggregates that impart a very crumbly or gravel-like structure, thus sometimes giving rise to the name "buck-shot land." This tendency to crumble is particularly true of the low, heavy phase nearest the Big Brazos. Clods are readily disintegrated by rains. The soil is very stiff and sticky when wet. Some narrow strips of a lighter material occur along the immediate front of the rivers.

The subsoil is a chocolate or red stiff clay frequently mottled with dark drab. No trace of grit can be detected in the greater part of the type lying along the Big Brazos, where the surface soil varies from a dark-chocolate stiff clay to a dark-colored clay loam passing into a silt loam. A section as seen in the bank of the Brazos shows a succession of chocolate, light-brown, and dark-red strata of varying thickness. Notwithstanding its extreme stickiness when wet, cultivation can be carried on within a comparatively short time following rains. The heavy, stiff character of the soil makes it necessary in breaking the ground to use a good strong team. Owing to the tendency of clods to crumble and disintegrate, fairly good tilth can be maintained. The high clay content would make this an extremely intractable, impervious type were it not for flocculation of the soil

particles by lime in which the soil is high. This renders the structure open and favorable to aeration and circulation of soil moisture, making this type as nearly perfect in this respect as any clay soil known. It is estimated that one plow can cultivate from 20 to 25 acres. The type carries only a moderate quantity of organic matter—about 3.50 per cent.

The Miller clay is confined to the lower bottoms of the Big and Little Brazos rivers. South of Calvert it occurs in two long, irregular belts following along the nearly parallel rivers and separated by a slightly higher lying belt of lighter soils. In the northern part of the county the entire bottom is occupied by the type. There are several detached areas here and there throughout the bottoms.

The Miller clay is an alluvial soil representing materials brought down from the red lands of northwest Texas. The timber growth is quite different from that of the Wabash clay of the Navasota bottom. Elm, pecan, cottonwood, ash, hackberry, boxelder, and occasional groves of cedar and privet constitute the main growth. Weeds grow rapidly, especially cockleburrs. Johnson grass is considered most troublesome, and a number of farms have depreciated in value on account of it.

Most of the type is under cultivation. It is considered one of the best cotton soils of Texas.^a Without interference from insect pests the yield ranges from one-half to 1 bale per acre. The average for 1906 was about one-half bale. During some of the bad boll weevil years many fields failed to produce enough to warrant picking. Corn generally yields from 20 to 40 bushels, though with favorable seasons more than 75 bushels have been made. It is the best corn soil in the bottom and averaged the best cotton yields before the advent of the boll weevil. Some heavy yields of cabbage and late tomatoes of excellent quality have been produced. The soil is admirably adapted to alfalfa, producing four to six cuttings a season. Good stands can be secured and kept by thoroughly pulverizing the seed bed and keeping stock off the first two years, and always in the spring until the plants have regained the vitality lost during cold weather. An ex-

^a In order to test the manurial requirements of this type of soil, a sample was collected from a field 5 miles west of Calvert which has been under cultivation for several years and has usually been devoted to the growing of cotton. In 1906 the field was in corn and in 1907 in cotton. This soil is a deposit laid down by the flood waters of the Brazos River and is considered very productive. Its lime content is apparently high, and the soil tends to break up into a granular structure. Cotton yields from one-half bale to 1 bale per acre, and corn 25 to 40 bushels per acre, with yields of 75 bushels per acre in seasons of favorable rainfall.

The fertilizer tests on this soil show good increase in growth resulting from an application of green cowpea vines and lime, with a small increase in growth from a liberal application of well-decomposed manure. None of the commercial fertilizers or lime used singly or in combination produced any appreciable increase in growth on the soil.

tension of the alfalfa industry would be advisable, but the "bottom farmers" seem attached to continuous cotton culture. Yields of over 300 gallons of ribbon-cane sirup are easily made. The soil is quite responsive to frequent cultivation. Most of the type requires four furrows for bedding for cotton or corn. The cotton crop is hoed by hand once or twice, cultivated with a sweep plow two or three times, and then "laid by." When the boll weevil was most destructive there were instances where good crops were made by intensive cultivation—five or six hoeings and frequent plowing.

The surface drainage of much of the type would be improved by ditching. Good results have been had by ditching both sides of turning rows, throwing the dirt to the center, and in this way permitting good drainage from the furrows. In the southern part of the county several farms have been protected from overflows by dikes. Some heavy crops of late tomatoes have been made by irrigating with water pumped from the river. A portion of the type is subject to occasional overflows, but the larger part lies above normal high water. The June flood of 1899 overflowed the entire bottoms.

The soil rents for \$5 to \$6 cash and is valued at \$40 to \$100 an acre, with little for sale. A considerable number of farmers have made fortunes on this land.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Miller clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16561, 16563.....	Soil.....	0.1	0.8	1.0	7.0	5.5	37.5	47.7
16562, 16564.....	Subsoil.....	.0	.3	1.0	8.1	5.6	41.7	43.2

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16561, 5.6 per cent; No. 16562, 5.8 per cent; No. 16563, 3.9 per cent; No. 16564, 6.0 per cent.

MILLER SILT LOAM.

The soil of the Miller silt loam is a light-chocolate or reddish-brown silt loam averaging about 18 inches in depth. Not infrequently the soil grades into the Miller fine sandy loam with such imperceptible changes that it is difficult to determine the exact boundaries between the two types. The soil grades into a slightly heavier material of chocolate or reddish-brown color. Thin strata of light-colored very fine sand and dark-colored silt clay occur in the subsoil, particularly near the Little Brazos. In the higher positions the subsoil sometimes is a light-brown very fine sandy loam.

The soil is inclined to run together when thoroughly wet and harden with subsequent open weather, but it is easily put into

excellent mellow tilth. The type largely occupies the almost imperceptible ridge included between the belts of Miller clay following the Big and Little Brazos rivers. This ridge in its highest position is only about 10 feet above the bank of the river. The surface is nearly flat or only slightly uneven and the drainage is excellent. The Miller silt loam represents material brought down from the Panhandle region and deposited in time of overflow.

Pecan, elm, ash, and hackberry constitute the principal forest growth. Cockleburrs are very troublesome. Colorado grass grows luxuriantly, but is comparatively easy to handle. Johnson grass gives the same trouble as on the Miller clay. Most of the type is under cultivation.

The Miller silt loam is especially adapted to cotton, the average yield being about the same as on the Miller clay. Corn does fairly well, but the average yield on account of drought is not as good as the productivity of the soil would indicate, the average being about 25 bushels an acre, although as high as 70 bushels is secured in favorable seasons. It generally makes a heavier growth of stalk and fodder than on the Miller clay. Alfalfa, ribbon cane, and sorghum do well. Truck crops, like onions, tomatoes, cabbage, beets, and sweet potatoes can be grown successfully. A few healthy peach trees were seen. Peaches and figs would thrive in the higher positions. Wheat and oats undoubtedly would do well, though neither is grown.

Owing to ease of cultivation and the good average yields, the Miller silt loam is generally considered the most desirable of the Brazos bottom soils. It is held at about \$40 to \$75 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Miller silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16571, 16573.....	Soil.....	0.0	0.1	0.0	0.3	5.5	76.9	17.3
16572, 16574.....	Subsoil.....	.0	.1	.1	.3	4.9	75.1	18.8

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16571, 4.7 per cent; No. 16572, 7.5 per cent; No. 16573, 5.1 per cent; No. 16574, 5.8 per cent.

MILLER FINE SANDY LOAM.

The Miller fine sandy loam is a light-brown to reddish-brown, slightly compact, very fine sandy loam, generally of light texture. At about 15 inches the soil grades into a lighter colored slightly heavier material. There are several areas in which the soil is darker

colored and heavier while the subsoil contains considerable medium sand and rests upon a red sandy clay.

The type is closely associated with the Miller silt loam, generally occupying hummocks, knolls, and low ridges. The topography of the typical light soil has been influenced by the shifting action of winds. Its origin is the same as that of the other Miller soils, except that deposition took place in more rapid currents. The soil can be cultivated with ease over a broad range of moisture conditions. Owing to its tendency to assume a compact surface structure, frequent shallow cultivation is necessary to enable crops to withstand drought well. The average yield of cotton would be about one-third bale an acre without interference from insects. Corn rarely does as well as on the Miller silt loam, yet some good crops are grown. Some difficulty is had in getting a stand of alfalfa.

The type is well adapted to truck crops and has good railway facilities. Irish potatoes, sweet potatoes, peas, tomatoes, radishes, lettuce, beets, watermelons, cantaloupes, and cucumbers would thrive. Peaches, pears, plums, figs, and small berries would do well. The type is at present devoted to general farming. Barn-yard manure and cowpeas turned under would increase the yields.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Miller fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16567, 16569.....	Soil.....	0.0	0.1	0.0	2.1	58.7	33.7	5.0
16568, 16570.....	Subsoil.....	.0	.1	.0	.2	31.4	59.3	8.7

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16567, 3.6 per cent; No. 16568, 5.6 per cent; No. 16569, 2.9 per cent; No. 16570, 5.0 per cent.

MILLER FINE SAND.

The Miller fine sand is a loose, light-brown, very fine sand 3 feet or more deep. It is of very limited extent, nearly the entire area mapped being included in one body southwest of Calvert. It was necessary to include a few patches with the Miller fine sandy loam on account of their small extent.

In its surface configuration the Miller fine sand is undulating or hummocky, having been influenced by wind action. The type is used for general farming and is suited to a variety of vegetables. The soil has depreciated considerably, especially since the June flood of 1899. Crops stand drought fairly well, but are sometimes injured by the drifting of the soil. The soil is badly in need of

organic matter. Barnyard manure and cowpeas turned under green would greatly improve the land.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Miller fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16565.....	Soil.....	0.0	0.1	0.0	32.4	57.1	7.4	2.8
16566.....	Subsoil.....	.0	.0	.0	20.9	71.1	4.8	3.2

MEADOW.

Meadow comprises that bottom land having too little uniformity of texture to warrant recognition as a definite type. It occurs largely as narrow strips along the lesser stream courses. While its texture is predominantly quite sandy, a small area may include silt loam, sandy loam, and deep sand.

Much of Meadow is under cultivation, and practically all of it along streams could be cultivated. Good yields of corn and cotton are made. It is especially adapted to the production of ribbon cane. Such marshy areas as the Big Marsh on Devils Jump Creek, however, are not susceptible of easy cultivation.

SUMMARY.

Robertson County is situated in the Gulf Coastal Plain in central-eastern Texas, about 150 miles from the Gulf of Mexico and 140 miles west of the Louisiana line. Of the total area of 545,600 acres, about 30 per cent is under cultivation.

The upland part of the county varies from flat to gently rolling in topography. The large streams have broad, productive bottoms. The surface slopes slightly to the southeast with the general direction of the Navasota and Brazos rivers, which mark, respectively, the eastern and western boundaries. Good drainage is afforded by a well-distributed system of waterways. The altitude of the upland varies from 300 to 375 feet along the southern boundary to about 550 feet at the highest point of the northern boundary. The lower bottom lands lie from 50 to 100 feet below the general upland.

The climate is healthful. The winters are usually mild, snow falls only occasionally, and zero weather is rare. The summers are long, but are not disagreeably warm. The normals for June, July, and August are 82°, 85°, and 84° F., respectively. Crops are rarely damaged by frosts. The annual precipitation is about 34 inches. Corn is sometimes injured by June and July droughts, but the damage could

be reduced by fall plowing and frequent surface cultivation. The climate is well suited to cotton, sugar cane, sorghum, fruits, and early vegetables.

The population of the county in 1900 was 31,480, composed largely of settlers and the descendants of settlers who came from older Southern States, principally Tennessee, Alabama, and Mississippi. There are a number of Germans, Poles, and Italians. A great many negroes, laborers and renters, live in the Brazos bottom.

The railroad facilities are good in the central and western parts of the county, but the northern and southern sections would be much benefited by the building of railroads. There are good local markets for staple products like cotton, corn, and hay. Considerable truck and fruit are canned at Franklin. Early Irish potatoes, tomatoes, small fruits, berries, cattle, and hogs are shipped to outside markets. Fruit and truck growing can be carried on profitably on a larger scale.

Cotton has been from the first and will continue to be the leading product. Until the advent of the boll weevil the production of cotton, corn, and small patches of sugar cane or sorghum, oats, and sweet potatoes, sometimes in conjunction with stock raising on a small scale, was the prevailing system. Early Irish potatoes and tomatoes have become profitable and important crops in certain sections near the railroads. A large number of peach trees have been set out. A great variety of early vegetables like radishes, lettuce, onions, English peas, spinach, turnips, beans, etc., do well on the upland soils, and could be marketed immediately after the very early Gulf coast crops. Sweet potatoes, cucumbers, cantaloupes, watermelons, blackberries, dewberries, figs, plums, and Kieffer pears also do well. Cowpeas and peanuts can be grown with advantage to the land and as profitable forage crops, especially for hogs. The Miller soils are well suited to alfalfa. Johnson and Bermuda grasses give considerable trouble, especially in the bottoms. They can best be eradicated by grazing the land close, plowing shallow the following summer, and growing clean cultivated crops the third year. These grasses, however, make excellent hay and can be grown profitably on creek bottom lands either for hay or pasture.

Systematic rotation of crops has never been practiced and very little manure has been applied to the soils. In short, the methods have been well suited to the exhaustion of organic matter and consequently soil deterioration. However, on the heavier types, many fields still produce good crops even after thirty years or more of nearly continuous cultivation to cotton. The upland soils are generally in need of vegetable manures. Barnyard manure and cowpeas are the most beneficial and economical fertilizers that can be used. Cowpeas improve all the soils, whether grazed down, cut off, or plowed under. Certain types, particularly the light sandy soils, would be greatly

benefited by occasionally plowing under a crop of green cowpeas and the addition of about 50 bushels of lime to the acre. Commercial fertilizers are coming into use on the uplands for cotton and Irish potatoes. Farmers should not depend too much upon these, as they are an expensive form of fertilizer, and are not lasting, especially on the sandy soils. Better results could be obtained from the use of commercial fertilizers in conjunction with some form of organic manure.

In attempts to make an early crop of cotton so as to get ahead of the boll weevil better methods are being worked out. Plowing and planting are generally begun earlier and the cultivation is shallower and more frequent. No fall plowing is done, although deep fall breaking, wherever possible, on all soils but the sands would go far toward conserving winter and spring moisture and putting the land in the best condition for a seed bed.

Labor is very scarce. Day laborers are paid from 75 cents to \$1.25. Tenants cultivate for "the half" where the landlord furnishes everything but the tenant's board. The Brazos bottom land rents for \$5 to \$6 and sells for about \$40 to \$75 an acre, according to character of soil, its position with reference to overflow, and freedom from Johnson grass. Good upland can be bought for \$5 to \$12 an acre, depending upon distance from the railroad. A large proportion of the upland soils of Robertson County offer opportunity for good investment, especially to the man of small means.

Twenty-seven types of soil, exclusive of Meadow, have been mapped. The uplands, comprising mixed prairie and timbered lands, vary in texture from sands to clays. The original timber growth upon the upland consists largely of hickory and post, black-jack, and sand-jack oaks. The bottoms or alluvial soils vary from black and chocolate-red sandy soils to clays. The bottom lands were originally timbered with pin oak, elm, ash, hackberry, cottonwood, etc. Very few of the soils are in need of underdrainage. The surface drainage of some of the flat or low-lying types, like the Lufkin fine sandy loam and the Miller clay, would be improved by constructing open ditches.

The Norfolk fine sand—a deep light sand—conserves moisture surprisingly well, and, when the supply of organic manure is sufficient, produces fair crops of cotton and corn. Vegetables, peaches, figs, small fruits, cowpeas, and peanuts do well.

The Norfolk fine sandy loam is an easily managed soil, well suited to general farming. It is susceptible of rapid and permanent improvement by the incorporation of vegetable manures. Good ribbon cane can be grown.

The Norfolk sand and the Norfolk sandy loam resemble quite closely the two preceding types, differing mainly in their higher con-

tents of medium and coarse sand. They are adapted to the same crops but are less productive. It is thought that grapes and strawberries would do well on these types.

The Orangeburg sand and Orangeburg sandy loam are both quite limited in extent. Irish potatoes and truck do well on these types. The sandy loam makes very fair yields of the general farm crops.

The Orangeburg fine sand is well suited to truck and makes fair crops of cotton and good crops of peanuts.

The Orangeburg fine sandy loam is the most productive of the upland soils, producing with proper management from one-half to 1 bale of cotton and from 25 to 40 bushels of corn per acre. Peaches, pears, plums, small fruits, like dewberries and blackberries, early Irish potatoes, and tomatoes do well.

The Orangeburg gravelly sandy loam is quite limited in extent. It has excellent drainage and is adapted to early English peas, lettuce, and tomatoes.

The Susquehanna fine sandy loam is the most extensive type of the area. It is a productive and desirable soil, being especially adapted to cotton, producing from one-third to one-half bale per acre with rather indifferent treatment. By growing cowpeas and using barnyard manure it can be built up rapidly, so as to produce one-half or even a bale of cotton in favorable seasons. Corn sometimes suffers from June and July droughts, but in good seasons yields more than 30 bushels per acre. The soil is inclined to be crusty after rains. It needs deep initial preparation and frequent shallow cultivation. Pears, onions, and beans do well. Oats sown in the fall make good yields. The Susquehanna fine sandy loam can be bought for \$8 to \$15 an acre.

The Susquehanna sandy loam is considerably less productive than the Susquehanna fine sandy loam. It is used for general farming. Cowpeas plowed under green would improve this soil.

The Susquehanna loam is very closely associated with the Susquehanna fine sandy loam and makes about the same yields. Oats do particularly well. Onions and cabbage would thrive on this soil.

The Lufkin fine sandy loam is a flat, compact, dark-gray soil having rather poor surface drainage. Very little is under cultivation. Where the surface drainage has been improved it makes good yields of cotton. Ribbon cane and sweet potatoes find favorable environments. Corn and Irish potatoes yield poorly.

The Lufkin clay is limited in area, and owing to its intractable structure and poor drainage is classed as an undesirable soil.

The Lufkin fine sand is a flat-lying, compact fine sand fairly well suited to cotton, corn, peanuts, cane, sorghum, and cowpeas.

The Crockett clay loam is quite variable in texture and color. The black phase yields upward of a bale of cotton per acre. Wherever the

soil is deep and not too gravelly good cotton and oats can be grown. The "hog wallow" phase is hard to manage. Attention must be paid to seasonable cultivation or the soil is likely to harden and become very intractable in dry weather.

The Crockett fine sandy loam and the Crockett gravelly loam are each of very limited occurrence. The former makes good yields of cotton, corn, and oats. The Crockett gravelly loam is not under cultivation, but as it is one of the earliest soils in the county early vegetables and truck crops could be grown with success.

The Wilson clay loam is a dark, stiff, intractable soil subject to drought. Very little of it is under cultivation. Fair yields of cotton and corn can be made with timely cultivation.

The Wilson fine sandy loam is an early soil and well suited to cotton. It is inclined to become crusty after rains and to bake in dry weather; hence particular care must be taken to cultivate frequently and at the proper time.

The Sanders loam is a productive bottom-land soil, producing from 40 to 75 bushels of corn per acre. Cotton and ribbon cane do well. Crops are sometimes damaged by overflow.

The Sanders silt loam is also a productive alluvial soil, the yields being about the same as on the Sanders loam.

The Wabash clay is a black, stiff, heavy soil largely subject to overflow. Very little of it is under cultivation. It is a very productive soil, producing from three-fourths to 1 bale of cotton and 30 to 75 bushels of corn per acre. All of that large body in the Navasota River bottom is heavily timbered with pin oak, elm, post oak, etc., and can be bought for \$2 to \$5 an acre.

The Miller clay is a heavy chocolate-red alluvial soil of the Brazos bottom. It is very well adapted to cotton and makes good yields of alfalfa and corn. It is held at \$40 to \$100 an acre with little for sale.

The Miller silt loam is also very desirable alluvial soil of the Brazos bottom. It is well suited to cotton and alfalfa and returns good yields of corn and ribbon cane.

The Miller fine sandy loam is less productive than the preceding Miller soils, but cotton yields well on it. Corn does fairly well in favorable seasons. Some good peach orchards could be established on this type. Vegetables, melons, and ribbon cane would also give good yields. This type needs organic manure.

The Miller fine sand is quite limited in extent. It is deficient in organic matter and is subject to drifting by wind action. It is especially suited to vegetables, but is used for cotton and corn.

Meadow consists of stream-bottom material and is too varied in character to be recognized as a definite soil type. Good crops of corn, cotton, and ribbon cane are made on it. It is all subject to reclamation by opening the channels, diking streams, and ditching.

SOIL SURVEY OF WILSON COUNTY, TEXAS.

By W. S. LYMAN and FRANK C. SCHROEDER.

DESCRIPTION OF THE AREA.

Wilson County is situated in the south-central part of Texas and is approximately 100 miles from the coast. The ninety-eighth meridian of longitude west passes through the county near the center and the twenty-ninth parallel, north latitude, crosses its southern part.

Wilson County is bounded on the north by Guadalupe County, on the northeast by Gonzales County, on the southeast by Karnes County, on the southwest by Atascosa County, and on the northwest by Bexar County. The county contains 501,312 acres, or about 783 square miles.

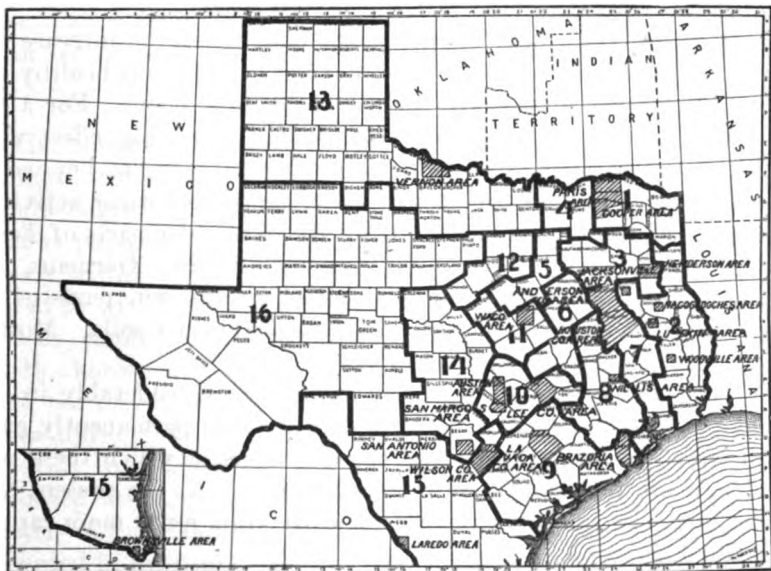


FIG. 20.—Sketch map showing location of the Wilson County area, Texas.

In elevation Wilson County varies from 375 feet to about 575 feet above sea level. It is inclined toward the southeast and has a general slope of about 8 feet to the mile. The topography of the county is for the most part gently rolling. The surface is divided into a series of broad, low parallel divides, between some of which are broad, level bottom lands. The most important of these is found along the San

Antonio River, whose bottoms are about three-quarters of a mile wide. The interdivide areas along the other streams are very narrow. The bluff lines along the bottom lands of the San Antonio and Cibolo rivers, while precipitous in some places, usually have gentle slopes, and the bottom lands are rarely more than 40 feet below the surrounding uplands.

The main drainage of the county is effected through the San Antonio River and its tributaries, all of which flow in a general southeasterly direction. The San Antonio River drains the western part, the Cibolo River, which is the main tributary of the San Antonio River, the central part, and Ecletto Creek the eastern part of the county. The extreme northeastern and extreme southwestern parts of the county are drained by tributaries of the Guadalupe and Atascosa rivers, respectively.

Artesian water is obtainable in some parts of the county. Some wells are located in the extreme southwestern part on the Stevens ranch and others are found near Floresville and Union.

The first permanent settlers in the county were Americans from some of the older Southern States. Since the civil war and up to the time of the ravages of the cotton boll weevil the population grew steadily. Just before the advent of the boll weevil the increase was more rapid than at any other time, but the growth was healthy and not of a character or of such extent as to cause a boom. For a few years the damage to the cotton crop had a depressing effect upon business and there was some emigration from the farms, but within the last year and a half the county has resumed its former activities. Immigration in late years has been chiefly from older parts of Texas, with a few newcomers from the Northern States. Germans, Bohemians, and Poles have gradually settled in different parts of the county, but chiefly in the southern half on the heavier soils. Most of them make thrifty, prosperous citizens.

The present conditions as to settlement vary considerably in different parts of the county. The first soils to be permanently cultivated were the sandy loams and those sections in which these soils are found are the more thickly settled to-day. At the present time the heavier soils are being cleared for cultivation much more rapidly than the other types.

In the more sparsely settled sections of the county stock ranching is still being carried on, though on a much smaller scale than formerly. The largest ranches are located on the heavier soils in the southern, southeastern, and southwestern parts of the county. The deep sandy section between Calaveras and Lavernia is devoted almost entirely to ranching. The principal farming area extends across the center of the county from southwest to northeast.

There are no large towns within the area. Floresville and Stockdale are the most important towns and principal local markets. Floresville, which is situated in the west-central part of the county, is the county seat and largest town, having a population of about 1,200. Stockdale, situated near the east-central part, has a population of about 950. Lavernia, in the northern part of the county, has a population of about 450.

There is practically no manufacturing in any of the towns within the county nor in any of the near-by cities outside the area, and all depend upon the agriculture of the surrounding district for support. At Saspanco there is a tile factory and at Calaveras a company making brick.

Wilson County is well supplied with transportation facilities. No part of the county is more than 13 miles from a railroad. The San Antonio and Aransas Pass Railway and the Galveston, Harrisburg, and San Antonio Railway pass through the western and eastern parts of the county, respectively. Both these systems furnish a ready access to all the markets of the State. San Antonio, the nearest large market, is but 30 miles from Floresville and 38 miles from Stockdale. Direct connections are also made over both railways with Gulf ports.

CLIMATE.

The climate of Wilson County is mild and healthful. There is neither extreme heat nor extreme cold. The latitude of the county would suggest much higher temperatures than exist, but excessive heat is prevented by the prevailing winds from the Gulf, which are nearly always to be felt. Occasional hot days are generally followed by cool, restful nights. During the winter months some rather sudden changes in temperature occur, when cold waves from the north, known as "northers," reach down into this section. But such periods of cold are of short duration, lasting rarely more than three days. The accompanying table shows the mean annual temperature to be about 69° F. The greatest extremes of heat and cold recorded at San Antonio, which is but 30 miles northwest of the center of the county, is 106° F., recorded in July, 1894, and 4° F., recorded in February, 1899. The average number of days in the year with maximum temperature above 90° is 94, and the average number of days with minimum below 32° is 12. The average depth of snow, also recorded at San Antonio, is 0.3 inch.

The annual rainfall of Wilson County is about 32 inches. This amount of rainfall is usually ample for farm crops, although occasionally dry years occur. The least precipitation recorded at San Antonio in any one year is 15.9 inches and the greatest 40.5 inches.

The following table, compiled from the records of the Weather Bureau, gives the mean annual and monthly temperature and precipitation at San Antonio and Runge, points about equal distances northwest and southeast of the county, respectively.

Normal monthly and annual temperature and precipitation.

Month.	San Antonio.		Runge.		Month.	San Antonio.		Runge.	
	Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.		Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.
	° F.	In.	° F.	In.		° F.	In.	° F.	In.
January.....	51.5	1.70	55.3	1.40	August.....	82.2	3.84	85.8	1.39
February.....	55.8	1.96	54.3	2.20	September....	77.5	3.41	80.2	3.68
March.....	61.9	2.05			October.....	69.7	1.67	73.1	2.45
April.....	70.1	2.98	70.4		November....	59.0	2.07	63.1	1.67
May.....	74.9	3.23	77.0	3.98	December.....	54.9	1.91	55.0	1.96
June.....	80.7	2.67	83.8	2.80	Year...	68.5	32.28		
July.....	83.3	4.79	85.2	2.41					

The following table, compiled from the same source, gives the dates of the last killing frost in the spring and the first in the fall for seven consecutive years. From this table it will be seen that the shortest growing season for tender vegetation, 213 days, occurred in 1900, and the longest, 311 days, in 1898, the average being about 275 days, or about nine months.

Dates of first and last killing frosts.

Year.	San Antonio.		Runge.		Year.	San Antonio.		Runge.	
	Last in spring.	First in fall.	Last in spring.	First in fall.		Last in spring.	First in fall.	Last in spring.	First in fall.
1898.....	Jan. 16	Nov. 22	None.	Nov. 22	1902.....	Feb. 16	Dec. 16	Feb. 16	Dec. 3
1899.....	Mar. 6	Dec. 4	Feb. 16	Dec. 4	1903.....	Feb. 18	Nov. 18	Feb. 16	Nov. 18
1900.....	Apr. 12	Nov. 12	Mar. 1	Nov. 13	1904.....	Feb. 12	Nov. 12	Feb. 21	Nov. 12
1901.....	Mar. 6	Dec. 10	Mar. 6	Dec. 14	Average..	Feb. 24	Nov. 26	Feb. 22	Nov. 25

AGRICULTURE.

When settlers first came to this part of Texas most of the land was open prairie. This they first devoted largely to cattle raising, other forms of agricultural pursuit receiving little or no attention. Practically no cotton was produced and very little corn was grown. The prairies were covered with tall grass and furnished feed for the cattle the year round. These conditions continued until some time after the civil war. Gradually the mesquite, which had been kept down by the practice of burning the grass in the fall and spring, began to gain ascendancy over the cattle ranges, and the once rich pastures began to wane. The number of cattle that could subsist in the open prairie land was greatly reduced, and, moreover, the county

had been gradually settled and put under cultivation, which also curtailed the extent of range, compelling the cattlemen to leave the county in quest of new grazing lands. This transition of the agricultural interests of Wilson County from cattle raising to general farming has been in gradual progress for the last twenty years.

The principal crops now grown, as has been the case from the beginning of agriculture in this region, are cotton and corn, though the cotton alone is marketed. Prior to the advent of the boll weevil cotton and corn were grown practically to the exclusion of all other crops. Since the appearance of this pest, however, other crops, such as peanuts, peas, sweet potatoes, sorghum, Johnson grass (for hay), some fruits, such as peaches and pears, and some vegetables have also been produced to a small extent. The growing of peanuts in connection with hog raising is becoming a profitable source of revenue.

Being a comparatively new section, where land is cheap and easily obtainable, but little attention has been paid to agricultural methods tending to conserve soil resources. The methods generally employed are superficial in character. They have doubtless up to this time satisfied the economic conditions, but the time is near at hand, if not already here, when it will pay to give more particular attention to the preparation of the seed bed, to subsequent cultivation, and to such practices as will result in the conservation of the greatest proportion of the soil moisture.

In this view the general type of agriculture in the county is capable of much higher development. While cotton and corn have been grown consecutively for a few years on some areas, most of them have as yet declined but little, if any, in productiveness. Probably not more than one-fifth of the total acreage of the county has as yet been cultivated. Fertilizers of any kind have been used only within the last two years, during which time a little commercial fertilizer has been applied to cotton in some fields.

The farmers of the county are prosperous. Those on the heavier soils have perhaps acquired more wealth, as is evident from the general appearance of the farms and buildings, but throughout the county all have both the necessities and comforts of life. In general, the heavier soils of the area are preferred as being the more productive. However, considerable depends on the character of the season and the methods of cultivation employed. During a droughty season, with the methods now in general use, somewhat larger yields are obtained from the sandy loam soils, while during other years the heavier soils lead.

For the production of cotton, corn, forage crops, and in general farming the Wilson clay loam and Wabash clay are the strongest soils in the area. Peaches, melons, potatoes, and peanuts do best on the sandy loam soils. Peanuts and peas could undoubtedly be grown

with profit on all the soil types in the area. The farmers in general have so far paid very little attention to the adaptation of soils to special crops, and the tendency is to grow all the cotton possible, regardless of the type used. It follows that rotation of crops is a question yet to be worked out. When cotton and corn are both grown they are usually alternated, but often cotton is planted on the same ground for a number of years.

Part of the land is plowed broadcast and part in ridges. In planting cotton many simply throw two furrows together on unbroken land, thus forming a ridge under which lies a strip of unbroken soil and on this ridge over the strip of hard soil the cotton is planted. For corn the land is more often plowed level. The plowing is always shallower than it should be to give the best results, regardless of the texture of the soil. Subsequent cultivation is from 3 to 4 inches deep and the ridge method is universally used. The plowing is usually done in the spring just before planting the crop.

The labor employed in the area consists of both white and colored. The first class is the most numerous and consists of German immigrants, who usually work by the month until they get a start and then buy property of their own, and of many Mexicans. The latter outnumber the negroes and are considered fairly efficient. The foreign element in the farming class does not hire much help, men, women, and children all working in the fields in the settlements made up of immigrants from other countries and their descendants.

There is a wide range in the size of farms in the county, and the size varies greatly on the different soil types. The Orangeburg fine sandy loam is divided into rather small farms, while the heavier soils and the deep sandy soils show much larger holdings. Some farms on the heavier soils consist of tracts of several thousand acres. The greater number of farms, however, taking the county as a whole, range in size from 100 to 640 acres.

A large majority of the farms are worked by the owners. Some of the farmers owning large tracts rent a part of their lands, and in this case it is the usual practice to take rent in the shape of a share of the produce, the landowner commonly receiving one-third of the corn and one-fourth of the cotton. Cash rent ranges from \$3 to \$4 an acre.

The value of farm lands is fairly uniform in different parts of the county. The variations occurring are due chiefly to location and type of soil and prices paid range from \$3 to \$35 an acre. In general the heavier soils are considered the most valuable farm lands in the county, and the Wilson clay loam and the Wabash clay are valued at from \$15 to \$35 an acre. Unimproved farms of these types of soil sell at from \$15 to \$20 an acre. The Norfolk fine sand is the

cheapest soil in the county, being sold for from \$3 to \$10 an acre. The sandy loam soils are valued at from \$10 to \$30, according to the improvements and location. There is thus a fine opportunity to secure paying farm lands in the county, even where only a limited capital is available.

Throughout the area there should be a greater diversification of crops grown. Not only is there a loss in the productivity of the soils where one crop is grown continuously, but farmers should guard against failures caused by unfavorable seasons, the ravages of insects or diseases, and by depressions in prices, all of which factors are likely to be more critical to a man who depends solely upon one line of endeavor.

There should be more attention paid to the rotation of crops. While all of the soils of the area would be benefited, the sandy soils are particularly in need of large quantities of organic matter for the best yields of crops. It is recommended that a rotation, including leguminous crops, such as peanuts and cowpeas, be followed where staple crops are grown. In cases where cotton rot is troublesome a rotation of corn, sorghum, and cotton has been found very beneficial.

The ridge method of plowing and subsequent cultivation should be dispensed with on all soils, except where level cultivation would not insure proper drainage. The depth of plowing should vary with the kind of soil. The sandy soils should be plowed shallow, while the heavier soils require to be broken more deeply, and on both plowing should be followed by shallow cultivation of crops. Plowing should also be done in the fall. The object in all cases should be to conserve soil moisture for the future use of crops. After each rain a shallow cultivation should be given whenever practical so as to form a mulch or "dust blanket," which, destroying capillary connection with the deeper soil, prevents the loss of soil moisture by evaporation.

SOILS.

Wilson County lies wholly within the Gulf Coastal Plain and its soils are very largely the weathered products of marine deposits of Eocene Tertiary time.

Extending across the northern half of the county from northeast to southwest are found a class of soils having compact clay subsoils carrying small quantities of fine sand and varying in color according to the amount of iron present, to the conditions of drainage, and to the degree of oxidation and aeration. Overlying these clays, to depths varying from 4 to 36 inches, is a veneering of sandy material varying in texture from a light sandy loam to a loose sand, the sand being of a fine grade. The soils found in this physiographic division belong to what are known as the Orangeburg and Webb series. In

areas mapped as Webb loam no sandy material overlies the clay, which has been exposed to direct surface weathering and has been modified to some extent by wind-blown material.

Running northeast and southwest across the sandy section of the county and near the northern edge is a broken belt of light-gray loose and incoherent medium to fine sand 3 feet or more in depth, which, in all probability, represents an ancient sea beach. This belt, which is, as a rule, quite broad, gives rise to a soil called Norfolk fine sand. Lying to the south of the sandy section of the county is a later geological formation, consisting of calcareous clays, also a marine deposit of Eocene Tertiary time. The Wilson clay loam is derived from this formation. The Wilson loam occurs between these calcareous clays and the sandy section first described and is formed by the intermingling of these two diverse classes of material.

The Bastrop fine sandy loam occurs as a level terrace lying about 20 feet above the bottom lands. Its origin probably dates back toward the Tertiary period. It was at one time in all probability subject to overflow. The higher ridges along the bluff lines bordering the river bottom are occupied by the hilly Susquehanna gravel. The derivation of the gravel content of this soil is probably from an older gravel deposit, while the sand which is found on the surface and mixed in with the gravel is from the same source as the sandy material forming the surface soil of the sandy upland types.

Along the streams are found areas of alluvial soil, but with the exception of Meadow they are seldom if ever overflowed. The texture of these bottom land soils varies with the character of the soils and the geological formations of the localities through which the streams flow. The Wabash clay is composed largely of material brought down from the black prairie region to the northward. The Austin fine sandy loam consists of coarser material deposited during Tertiary time along the immediate banks of the San Antonio River and to some extent along the Cibolo River. It has in all probability been brought down from the less humid region still farther northwest than the material of which the Wabash clay is composed. In the case of the soil called Meadow the material is a wash from the surrounding light sandy upland soils.

The following table gives the area of each type of soil found in Wilson County. The location and distribution of the several types is shown by color on the accompanying soil map.

Areas of different soils.

Soils.	Acres.	Percent.	Soils.	Acres.	Percent.
Wilson loam.....	97,216	19.4	Webb loam.....	17,088	3.4
Webb fine sandy loam.....	89,280	17.8	Austin fine sandy loam.....	11,136	2.3
Orangeburg fine sandy loam.....	77,056	15.4	Bastrop fine sandy loam.....	5,824	1.2
Norfolk fine sand.....	68,032	13.6	Meadow.....	4,544	.9
Wilson clay loam.....	52,416	10.2	Susquehanna gravel.....	1,152	.2
Orangeburg fine sand.....	49,408	9.9			
Wabash clay.....	28,160	5.7	Total.....	501,312	

WILSON CLAY LOAM.

The soil of the Wilson clay loam is a clay loam or clay, dark brown or black in color, and sometimes streaked with a yellowish tinge. It is quite sticky when wet, but friable and loamy when dry and in a well cultivated condition. Its physical properties give it great water-holding capacity, a valuable feature in this region. In its virgin state the surface becomes hard, baked, and sun-cracked. The soil at about 10 inches grades into a dark-brown or black clay, which becomes heavier in texture and lighter in color as depth increases. At 36 inches it is a stiff, compact clay often tinged with yellow. With the exception of one or two areas in the southwestern part of the survey, which are somewhat heavier in texture, darker in color, and more inclined to sun-crack; the type is very uniform in texture.

The Wilson clay loam occurs in bodies of greater or less extent in that half of the county bordering Karnes County. The largest areas are found in the southern part of the county west of the San Antonio River and in the eastern part south and east of Pandora. The topography is gently rolling. The slopes are long and gradual, with wide, shallow valleys between them. The surface affords good natural drainage and only a few areas need to be drained artificially.

The Wilson clay loam is derived from the weathering of Coastal Plain deposits consisting of calcareous clays of Eocene Tertiary age, which give rise to this fertile soil over a wide belt in Texas.

This type of soil, when found near the railroads, is largely under cultivation, but in the more remote sections is used almost entirely for pasture. It is the strongest upland soil in the area for staple crops. Cotton averages from five-eighths to three-fourths of a bale per acre, and when especially well cultivated in favorable seasons much larger yields are obtained. Corn produces on the average from 30 to 40 bushels per acre, but varies with the seasons, much larger yields being obtained during a wet season. Sorghum cane, while not extensively grown, yields from 2 to 3 tons per acre, from the 1 to 3 cuttings which are made each year. When properly culti-

vated this soil has strong drought-resisting qualities, and much of the fluctuation in yield now experienced by the farmers can be obviated by putting into practice a system of culture designed to conserve the soil moisture.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of the Wilson clay loam:

Mechanical analyses of Wilson clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16407, 16409.....	Soil.....	0.1	0.9	1.5	12.6	16.6	49.2	18.6
16408, 16410.....	Subsoil.....	.1	.5	1.6	9.6	10.4	44.4	33.0

WILSON LOAM.

The surface soil of the Wilson loam consists of 10 inches of dark-gray or sometimes a dark brownish-gray loam, containing a considerable quantity of sand, which renders the surface friable and easily worked. A few small, rounded pebbles are occasionally found on the surface and in the soil and subsoil. The subsoil is a drab silty clay or heavy loam, containing a very small quantity of fine sand. It becomes lighter in color and heavier in texture as the depth increases and at 40 inches is a stiff, tenacious, silty clay, the color of which is often tinged with yellow.

The type occurs in irregular-shaped bodies scattered promiscuously over the western, southern, and eastern parts of the survey. As a rule these bodies occur in long, rather narrow areas, running in a general northeast and southwest direction.

Areas embraced by this type occur between the heavy black prairie clay soils and the sandy soils, the type being formed by the intermingling of these two classes of material. Its origin is indicated by the fact that bordering the sandy soils the type contains more sand, while near the black prairie clay soils it is heavier. A considerable quantity of the sand in the more sandy areas is wind-blown material from the adjacent areas of the sandy types. However, the greater part of the type represented is the mean result of the intermingling of the two materials.

The topography of the Wilson loam is slightly rolling. The surface is sloping enough to afford good natural drainage. Along a few of the larger stream courses there is a tendency to wash, but erosion has seldom taken place to such an extent as to interfere with the use of modern machinery.

This type is not as extensively cultivated as the Wilson clay loam, and up to the present time not many areas have been cleared of the

rather heavy mesquite growth. The areas are used very largely for pasture. The few fields under cultivation are devoted solely to the production of the staple crops. The Wilson loam is best adapted to early maturing crops because of its droughty nature. Although this soil has great water-holding capacity its texture allows capillarity to work freely and rapidly, and unless methods of cultivation are used to conserve moisture, crops quickly suffer during dry spells. Crops are often affected on this type, while on others from which evaporation takes place more slowly they do not suffer. With the methods now in general use and in ordinary seasons, cotton yields from one-half to five-eighths bale per acre and corn 25 to 30 bushels. Sorghum cane is grown with good results.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Wilson loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16403, 16405.....	Soil.....	0.2	0.4	1.4	26.1	33.1	24.0	14.0
16404, 16406.....	Subsoil.....	1.2	1.1	1.0	19.9	32.1	25.4	18.8

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16406, 0.7 per cent.

NORFOLK FINE SAND.

The Norfolk fine sand consists of a very light gray, loose and incoherent fine to medium sand, more than 3 feet in depth. There is little or no difference between soil and subsoil except that the surface 2 or 3 inches is usually slightly darker in color, owing to the accumulation of a small amount of organic matter. Occasionally at 40 inches is found a red and light-gray mottled sandy clay. In one or two of the more level areas, where the clay seldom comes within 40 inches of the surface, there is no mottling in the underlying stratum, which is of a solid light-gray color.

This soil is found in rather large bodies extending across the northern part of the county in a general northwest and southeast direction. The topography is, for the most part, gently rolling, but occasional areas occur which are found to be rather level while others are more rolling. The depth of the sand and its topography insure perfect drainage.

The Norfolk fine sand is an Eocene Tertiary deposit and represents, in all probability, an ancient sea beach now more or less weathered. Broken remnants of this ancient sea beach are found extending parallel with the coast for a considerable distance across the State.

This soil type is generally regarded as of little agricultural value and is used almost entirely for pasture. Only now and then are small cultivated fields to be found, and they are situated chiefly near the line of contact with adjoining soils. Cotton, peanuts, and sweet potatoes are about the only crops grown. A very small acreage is given to corn, but it does not produce remunerative yields. The yield of cotton is also small, averaging from one-fourth to one-third bale per acre. Peanuts do well and if grown in connection with hog raising would undoubtedly prove profitable. Peaches if properly cultivated would do well, and excellent yields of melons and grapes could undoubtedly be produced. While held in low esteem under present conditions in Wilson County, this is a valuable type of soil for certain special industries, such as trucking and small fruit growing.

The Norfolk fine said is not as droughty a soil as might be supposed, for the fine sand of which it is composed allows fair movement of capillary moisture and the surface soil when dry acts as a natural mulch, thus reducing evaporation to a minimum. The deficiency in organic matter in the soil could be overcome by green manuring, and such treatment would also increase the water-holding power of the type.

The following table gives the results of mechanical analyses of the soil and subsoil of the Norfolk fine sand:

Mechanical analyses of Norfolk fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16411.....	Soil.....	0.3	8.8	11.1	59.9	10.4	8.6	0.5
16412.....	Subsoil.....	.3	9.0	11.6	58.2	12.2	8.2	.9

ORANGEBURG FINE SAND.

The soil of the Orangeburg fine sand is a reddish-gray sand, ranging in depth from 15 to 36 inches, and having an average depth of about 2 feet. The subsoil is a red or mottled red and light-gray and occasionally a light-drab clay, always containing a considerable proportion of fine sand.

This type is found scattered throughout the northern sandy section of the county. It occurs as a gradation soil between the Norfolk fine sand and the Orangeburg fine sandy loam or, in a few instances, between the Norfolk fine sand and the Webb fine sandy loam. The topography of the areas is uniformly gently rolling or undulating, and they are naturally well drained.

The material from which the Orangeburg fine sand is derived is Eocene Tertiary in age. The greater depth of sand in local areas has undoubtedly been brought about by wind action, but how great

a part this has played in the formation of the soil as a whole can not be stated. It is probable that much fine material, such as found in the subsoil, has been removed from the surface material in the drainage waters, so that the present condition of the surface has in part resulted from the sorting action of water.

The crops now grown on this soil are cotton, some peanuts, sweet potatoes, and a very little corn, the latter being an uncertain crop. Cotton produces on the average from three-eighths to one-half bale per acre. This soil is well adapted to melons, peaches, sweet potatoes, grapes, and peanuts. The type is deficient in organic matter, and systematic green manuring, together with the introduction of leguminous crops, such as peanuts and peas, into the rotation, is recommended.

The following table shows the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Orangeburg fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16413, 16415.....	Soil.....	0.1	6.6	7.1	54.2	19.3	8.3	5.1
16414, 16416.....	Subsoil.....	.1	8.2	9.6	25.0	7.6	18.7	30.4

ORANGEBURG FINE SANDY LOAM.

The Orangeburg fine sandy loam is locally known as "post oak land." The soil is a fine, loamy sand, reddish brown or gray in color and variable in depth, ranging from 6 to 15 inches, with an average of about 13 inches. Road cuts and borings in fields show the depth of the soil to be very irregular, the clay subsoil coming close to the surface, then dropping rather abruptly to 15 inches, only to come close to the surface again, all within an area of a few square feet. The subsoil varies from a red to a reddish-brown or yellowish-red clay, containing a relatively small quantity of fine sand. Iron concretions are found in both soil and subsoil.

The greater part of the Orangeburg fine sandy loam is found in the central and northeastern parts of the county. Other small areas occur near Lavernia, in the northern part, and near Fair View, in the northwestern part. The surface is for the most part rolling. Some areas near the heavier soils are more level, while other scattered bodies may be more broken than the greater proportion of the type. The hills are low and rounded and the valleys between them rather narrow as compared with those in other parts of the county. With the exception of a few small stony areas on the crests of hills and erosions along some of the streams, which are frequently deeply gul-
lied, the type is all arable land.

The topography of this soil, together with the many stream courses that intersect this section, afford good surface drainage. The sub-drainage, however, is not as good as that of the surface and during a very wet year there is a tendency for the soil to "run together," a condition caused by the close impervious subsoil which does not absorb moisture readily, but holds it in the fine sandy soil above, where its movement upward and laterally is slow. This keeps the soil in a wet, soggy condition, unfavorable to the healthy growth of crops.

The Orangeburg fine sandy loam is derived from Eocene Tertiary deposits. Small spots, in which the soil is more than 15 inches deep, occur promiscuously scattered within this soil type and when large enough to be mapped on the scale used were classed as Orangeburg fine sand.

The Orangeburg fine sandy loam is one of the most extensively cultivated soils in the county. The early settlers preferred this soil because it was thought to be more resistant to drought and to produce larger yields one year taken with another. The general opinion has since changed and the heavier soils are now usually preferred. However, during a dry year and with the methods now in general use larger yields of the staple crops are secured from this type than from the heavier ones.

The Orangeburg fine sandy loam in ordinary seasons is not as well adapted to the staple crops as the heavier soils. It is, however, adapted to a greater variety of crops, and fair yields of the staple crops are secured. It is an excellent peach and a good truck soil, and would in all probability produce a good quality of cigar tobacco. Melons, plums, pears, Irish and sweet potatoes, beans, peas, and peanuts do well on this soil. Cotton yields on the average about one-half bale per acre and corn from 20 to 25 bushels.

The following table shows the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16419, 16421.....	Soil.....	0.2	0.3	0.5	26.1	53.9	15.1	4.0
16420, 16422.....	Subsoil.....	.2	.2	.4	20.9	27.2	19.9	31.4

WEBB FINE SANDY LOAM.

The Webb fine sandy loam is locally known as "red sandy mesquite land." While in some respects this soil is quite closely related to the Orangeburg fine sandy loam, in others it is quite distinct. The main

differences between the two types are found in timber growth, topography, productiveness, and depth of soil. The soil of the Webb fine sandy loam is also more loamy, and both soil and subsoil have a somewhat darker color.

The surface soil of the Webb fine sandy loam is quite uniform as to depth, averaging not more than 10 inches. It is a dark-brown or reddish-brown light sandy loam or a heavy loamy sand. The subsoil is a dark-brown, reddish, or yellowish-brown clay, mottled, especially in the lower depths, and containing a perceptible quantity of fine sand. In both soil and subsoil are found small quantities of iron concretions and also occasionally a few small rounded pebbles.

A large part of this type of soil occurs in the northern half of the county, west of the San Antonio River. Other quite extensive areas are located in the vicinity of Kosciusko, Poth, and west of Dewees, near the Atascosa County line.

The type occupies undulating or gently rolling areas and has good surface drainage. The crops, however, suffer from poor subdrainage to about the same degree that they do on the Orangeburg fine sandy loam. The Webb fine sandy loam is rather easily eroded, but is seldom affected to such an extent as seriously to interfere with cultivation.

The fine sands and clays from which this soil is derived are the remains of a deposit laid down in the Eocene Tertiary period.

The Webb fine sandy loam is one of the strongest sandy soils in the area. Cotton, corn, Irish and sweet potatoes, peanuts, sorghum, peas, melons, and some other garden vegetables are grown on this type. The yields vary to some extent with the season, as on the Orangeburg fine sandy loam, though to a less extent. Cotton will yield from one-half to five-eighths bale and corn about 25 bushels per acre. Excellent yields of melons, peanuts, peas, and vegetables are obtained, but crops requiring heavy or rich organic soils, as for instance, cabbage, and onions, are not recommended. There are a few small orchards, which are in a flourishing condition. Peaches do very well, and pears, where not affected by blight, are grown with good success.

The following table shows the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Webb fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16417.....	Soil.....	0.0	0.5	0.3	53.9	19.8	20.5	5.0
16418.....	Subsoil....	.1	.3	.4	24.6	15.7	29.1	29.9

WEBB LOAM.

The surface soil of the Webb loam consists of about 10 inches of rather heavy reddish-brown loam. The subsoil is reddish-brown or brown clay loam, grading at about 24 inches into a stiff, compact, red or yellowish-red clay. In both soil and subsoil are found a few iron concretions and occasionally a few rounded pebbles.

The derivation of this soil is from material of Eocene Tertiary time. Areas bordering the sandy soils are usually somewhat more sandy than in typical developments. A considerable part of the sand content in such areas is wind-blown material from the adjoining sandy areas. However, the greater part of the type has not been influenced in this way.

The Webb loam is one of the less extensive soils in the area. It occurs in small, irregular-shaped bodies within areas of Webb fine sandy loam or between the latter type and areas of Wilson loam. The soil has a gently undulating surface and is well drained.

But a few small areas of this soil have been cleared of the rather heavy growth of mesquite and placed under cultivation. Cotton, corn, and sorghum are the only crops grown, and yields are about equal to those of the other heavy soils of the county. Cotton yields on the average between one-half and five-eighths bale per acre and corn from 25 to 30 bushels. This type is a strong soil, adapted to the staple crops and to general farming.

The following table shows the results of mechanical analyses of the soil and subsoil of the Webb loam.

Mechanical analyses of Webb loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16423.....	Soil.....	0.5	1.8	1.7	13.8	34.2	24.1	23.7
16424.....	Subsoil.....	1.4	2.3	1.3	9.7	24.2	27.3	32.9

AUSTIN FINE SANDY LOAM.

The soil of the Austin fine sandy loam is a yellowish-gray or gray heavy fine sandy loam containing a considerable amount of silt. There is no marked difference between soil and subsoil and, as seen along the river banks, the same material extends to a depth of 10 or 12 feet without change. At this lower depth the subsoil suddenly becomes a very dark-gray or drab heavy silty clay. From the surface to a depth of 3 feet the soil gradually becomes lighter in color. Throughout the material occur many shells, and this has given rise to the local name "shelly land."

The Austin fine sandy loam is found skirting the San Antonio River and to some extent the Cibolo River. The areas are usually narrow, seldom extending back more than one-fourth of a mile from the streams. The soil is derived from material brought down by the streams during floods at a time when the stream beds were at a higher level than now. The topography is flat, but the surface is elevated from 20 to 30 feet above the present level of the streams. Occasional deep arroyos have been cut through the areas by intermittent streams. The type is well drained and, with the exception of a few low spots, is seldom if ever overflowed.

Attempts to irrigate the Austin fine sandy loam have not been successful, for the reason that the texture of the soil is such that water flows but a short distance before percolating into the soil. Corn and cotton are the crops usually grown. Cotton produces from one-half to five-eighths bale and corn about 25 bushels per acre. It is quite probable that certain truck crops, for instance tomatoes, cucumbers, cabbage, and cauliflower, could be successfully grown. Irish potatoes would also do well.

Care must be taken to keep this soil well mulched, for its fine texture and tilth allow rapid loss of moisture by evaporation, and a few days of neglect during hot, windy weather may so reduce the water supply as to injure growing crops.

The results of mechanical analyses of samples of the soil and subsoil of the Austin fine sandy loam are given in the following table:

Mechanical analyses of Austin fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16401.....	Soil.....	0.3	0.3	1.7	55.6	17.7	15.0	8.8
16402.....	Subsoil.....	.0	.3	1.3	33.2	24.2	27.1	13.6

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16401, 30.2 per cent; No. 16402, 41.7 per cent.

WABASH CLAY.

The Wabash clay consists of a very dark-gray or black clay or clay loam 10 inches deep, grading into a stiff, tenacious clay subsoil, slightly lighter in color than the soil and becoming heavier in texture and still lighter in color as the depth increases. This soil is very stiff and tenacious when wet and on drying it bakes very hard and cracks. Many of the cracks are 3 or 4 inches wide and 2 feet or more deep. A few small areas occur which are slightly lighter in texture and color than the typical soil. This condition is due to the admixture of sandy material brought down from the adjacent uplands. A few such sandy areas are found along the San Antonio River near Floresville and also scattered along the Cibolo River, but

they are so intermingled with areas of the typical soil as to make it impracticable to attempt their separation as a distinct type.

The Wabash clay occurs farther back from the rivers than the Austin fine sandy loam, which occupies their immediate banks. The areas vary from one-fourth mile to 1 mile in width, the extent being greater at the junction of the subsidiary streams with the San Antonio and Cibolo rivers.

The surface of the Wabash clay is practically level. It shows one peculiar feature known as "hog wallows." These "hog wallows," which are depressions from 6 to 12 inches deep and 3 or 4 feet broad, are scattered irregularly through the areas. The surface is also made uneven by the courses of intermittent streams from the adjacent highlands, which have often eroded deep channels through this type. The areas lie at practically the same height above the streams as the Austin fine sandy loam. Except for a few small, shallow, basinlike depressions, which could easily be drained by means of open ditches, the bodies of this type of soil are adequately drained, while owing to their elevation above the streams they are seldom if ever overflowed.

The Wabash clay is of sedimentary origin, being composed of the finer particles of soil carried in suspension by the streams in times of overflow and deposited when their beds stood at a higher level than at present.

This is one of the strongest and most productive soils in the Wilson County area. It is an excellent cotton soil, and corn, sorghum, and millet do well. In an average season cotton yields from five-eighths to three-fourths bale and corn from 30 to 40 bushels per acre. Excellent yields of forage crops are produced. In a few instances small areas of onions have been grown under irrigation on this type, and it is possible that onion growing on a large scale could be made a paying industry here.

The Wabash clay is often desired because of its location near the river, where water for stock is easily obtainable. The cost of clearing the land for cultivation is usually somewhat greater than in the case of the other types in the area, because of the heavy growth of mesquite and chaparral. Some scattered liveoak and willow are also found on the type.

The following table shows the result of the mechanical analyses of a sample of soil and subsoil of this type.

Mechanical analyses of Wabash clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16425.....	Soil.....	0.5	1.3	3.2	22.5	14.4	23.9	33.8
16426.....	Subsoil.....	.3	.7	.7	3.6	5.1	44.9	45.5

BASTROP FINE SANDY LOAM.

The Bastrop fine sandy loam is a chocolate or dark-brown fine to medium heavy sandy loam, 18 inches deep, underlain by a dark-brown sandy clay subsoil, becoming lighter in color and less sandy as depth increases and at 30 inches changing to a stiff red or yellowish-red sandy clay.

The Bastrop fine sandy loam occurs as level terraces bordering the river bottom lands and lies about 20 feet above the areas of the Wabash clay. The type is of sedimentary origin and its formation probably reaches back to Eocene Tertiary time. The areas were seemingly at one time a part of the river flood plain.

This soil has a moderate organic matter content and great water-holding capacity. The loamy soil allows a ready absorption of the rain waters and the stiff compact subsoil tends to hold the moisture within the reach of crops. While the surface is level the areas are adequately drained.

The Bastrop fine sandy loam is not an extensive soil, embracing an area of but a few square miles. It is found in relatively small scattered areas—the largest contains about 3 square miles—bordering the bottom lands of the San Antonio and Cibolo rivers.

Very good yields of cotton and corn are secured from this soil, cotton producing from five-eighths to three-fourths bale and corn from 35 to 40 bushels per acre. Good yields of sorghum and excellent yields of Irish potatoes and peanuts are produced. It is probable that certain varieties of peas would do well.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Bastrop fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16429.....	Soil.....	0.0	1.5	6.1	45.7	21.5	13.0	12.0
16430.....	Subsoil.....	.0	1.5	4.6	37.0	16.9	22.5	17.7

MEADOW.

The Meadow of Wilson County consists of narrow strips of bottom-land along the smaller streams. Such areas have a wide variation both in texture and in depth of soil and subsoil. Sometimes they consist of fine loamy sand over 3 feet deep, and again of more clayey material. As a whole, however, the soil is light in texture, and usually consists of from 12 to 26 inches of a gray to dark-brown fine loamy sand. The subsoil is a dark-gray fine loamy sand of about the same texture as the soil. The proportion of the finer grades of

material varies considerably and in the deeper subsoil—26 to 40 inches—is sometimes high enough to give a sandy clay texture.

The soil is of recent alluvial origin, being derived from material washed down from the surrounding light fine sandy upland soils. The Meadow is subject to overflow, but both the surface drainage and underdrainage are good and crops seldom suffer from excess of moisture. The principal areas of this type are found along Ecletto, Saibajet, and Marcelinas creeks. The type is under cultivation only in a few very small areas, in which good yields of cotton and corn are produced. It is believed that the Meadow is well adapted to the growing of cucumbers, melons, tomatoes, and other garden vegetables.

SUSQUEHANNA GRAVEL.

The soil of the Susquehanna gravel is a fine to medium light red-dish-gray sand, containing from 30 to 75 per cent of rounded gravel and small cobbles scattered on the surface and through the soil itself. The surface 2 or 3 inches is often slightly darker in color than the material beneath, owing to the accumulation of a small quantity of organic matter. At a depth varying from 18 to 36 inches, the subsoil grades abruptly into a red and gray mottled or sometimes yellowish-red or light-drab sandy clay, which becomes heavier in texture and less sandy as depth increases.

The Susquehanna gravel has a very limited extent, covering an area of about 2 square miles in all. It is found most typically developed in the northern part of the county near Lavernia, where it skirts the river bluffs bordering the bottom lands.

The Susquehanna gravel is probably the result of the intermingling of the materials of two different sedimentations. The interstitial fine earth is the same as the material forming the sandy soils of the county, while the gravel and cobbles come from a later coarser deposit.

The Susquehanna gravel is hilly in character and covered with a growth of hardwood, mostly black-jack oak and post oak. The drainage, because of the topography and the open gravelly texture of the material, is excessive. The soil is not adapted to the general crops grown in the area, owing to its droughty nature, and, moreover, practically all of the area is too gravelly to be readily cultivated.

The following table shows the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Susquehanna gravel.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16427.....	Soil.....	1.3	11.7	39.4	35.0	7.4	3.1	2.7
16428.....	Subsoil.....	.1	3.7	37.2	28.1	1.5	2.4	26.5

SUMMARY.

Wilson County, Tex., is situated approximately 100 miles from the Gulf of Mexico, in the south-central part of the State. The surface, which varies in elevation from about 575 feet to 375 feet above sea level, is generally rolling. The regional drainage is good and is effected almost entirely through the San Antonio River and its tributaries.

There is no manufacturing within or near the county and the main dependence of the population is upon agriculture and cattle grazing. Floresville, with a population of about 1,200, is the county seat and largest town.

Wilson County is crossed by the San Antonio and Aransas Pass Railway and the Galveston, Harrisburg, and San Antonio Railway, which furnish communications with all the large markets of the State. No part of the county is more than 13 miles from a railroad.

The climate of the county is mild, equable, and healthful. Temperature during the summer is modified by the prevailing Gulf breezes and occasional hot days are nearly always followed by cool, restful nights. The annual rainfall is about 32 inches.

Wilson County is comparatively thickly settled, except in the deep sandy section and in the parts more remote from railroads. In the thinly settled sections stock ranching is still carried on, though on a much smaller scale than formerly. Cotton is the dominant crop, the production of corn not always supplying the home demand. Other crops grown are sorghum, peanuts, sweet and Irish potatoes, cowpeas, Johnson grass, some fruits, such as peaches and pears, and a very few vegetables. So far very little attention has been paid to specialization in the adaptation of the soils to crops, to the rotation of crops or to intensive methods of cultivation. In general the heavier soils of the county are preferred as being the more productive. Probably not more than one-fifth of the area of the county has ever been under cultivation.

The prices of farm lands have advanced within the last few years, owing to the high prices of cotton, but are yet, on a basis of their earning capacity, remarkably cheap. Farms can be secured for \$3 to \$35 an acre.

Wilson County lies wholly within the Gulf Coastal Plain and its soils are very largely the weathered products of marine deposits of Eocene Tertiary time. Twelve types, varying in texture from a loose, incoherent fine sand to a heavy clay, were mapped in the county. The various types are adapted to a wide diversity of crops and most of them are strong arable soils.

The Wilson clay loam is one of the most durable general farming soils in the county, it being well adapted to forage crops, such as sorghum and certain grasses, as well as to the staples.

The Wilson loam is also a productive soil, though more inclined to suffer from drought than the clay loam type and, therefore, requiring more careful methods of cultivation than some of the other soils.

The Norfolk fine sand has little agricultural value at present except for pasture. It is deficient in organic matter and would be much improved by growing leguminous crops for green manuring. Peanuts, sweet potatoes, and peaches do well and excellent yields of melons and grapes are obtained.

The Orangeburg fine sand is somewhat more productive than the Norfolk fine sand and is adapted to about the same crops.

The Orangeburg fine sandy loam is not as productive as the heavier black prairie soils, but is adapted to a greater diversity of crops. In very dry years, with the methods now in use, larger yields are obtained from this type than on the prairie soils, but in other seasons the heavier soils generally lead. It is an excellent peach and a good truck soil, especially well adapted to melons, Irish and sweet potatoes, beans, peas, and peanuts.

The Webb fine sandy loam is a little more productive than the Orangeburg fine sandy loam and is adapted to the same crops and has about the same relation to climatic conditions.

The Webb loam is a strong soil and adapted to general farming and the staple crops.

Of the bottom land soils, the Wabash clay is most highly valued. It is one of the most durable in the area, and well adapted to the staple crops. Good yields of cotton and corn are also secured from the Austin fine sandy loam, while some of the truck crops do well. This type is inclined to be droughty unless methods of moisture conservation are used.

The Meadow is quite variable as to texture and depth of soil and subsoil. While it is subject to overflows, they are of short duration and do not seriously interfere with cultivation. The type is probably best adapted to the production of cucumbers, melons, tomatoes, and other vegetables.

The Bastrop fine sandy loam occurs as a terrace along the larger streams of the county. Good yields of cotton and corn are produced and also excellent yields of Irish potatoes and peanuts.

The Susquehanna gravel is hilly in character and covered with a growth of hardwood. Practically all of the type is too gravelly to be readily cultivated.

Only about one-fifth of the area of Wilson County is under cultivation, while almost the entire area, consisting as it does of productive soils of varied adaptations, could be used for farming or gardening. With the moderate prices now asked for land, and with the excellent shipping facilities, the county offers a fine opportunity for the agriculturist, whether he be a grower of the great staples or a specialist.

SOIL SURVEY OF BASTROP COUNTY, TEXAS.

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DESCRIPTION OF THE AREA.

Bastrop County comprises an area of 928 square miles.^a The county is situated a little southeast of the center of the State of Texas, being crossed by parallel 30° N., and lying just to the west of meridian 97° W. It is bounded by Travis and Lee counties on the north, Lee and Fayette counties on the east, Fayette and Caldwell counties on the south, and Caldwell and Travis counties on the west.

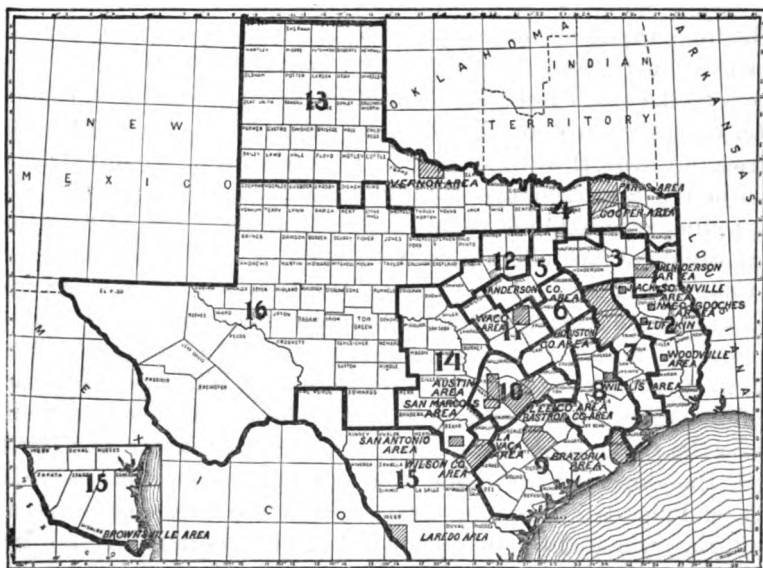


FIG. 21.—Sketch map showing location of the Bastrop County area, Texas.

In shape it is roughly a parallelogram, with its longest dimension from north to south.

The county was created March 17, 1836, and named for Baron de Bastrop. In April, 1837, it was organized, with Bastrop as the county seat, which distinction that town still bears. It is the oldest town in the county and one of the oldest in the State.

^a Seventy-eight square miles of this was surveyed in the San Marcos and Austin surveys, but is included in the present map to complete the county.

Bastrop County is an agricultural community, having, however, a few industrial enterprises in coal mining, brick making, pottery, and lumber. Glenham and Phelan, on the Missouri, Kansas and Texas Railway, between Bastrop and Elgin, are coal-mine stations. From both of these mines a good grade of lignite is obtained. The seams vary in thickness from 3 to 8 feet and appear at from 60 to 125 feet below the surface. The average daily output of both mines is about 250 tons, carrying a value of from \$1 to \$2 a ton. Brick making is very successfully promoted at and around Elgin, where excellent grades of brick clay and fire clay are to be had in abundance. A pottery plant is operated at McDade, in the northern section of the county, where a good grade material is turned out from the native surrounding clays. Lumber is cut extensively over the sand hills and gravelly ridges in the central section of the county, with Bastrop and Smithville as distributing points. There is a comprehensive and efficient system of telephone connections throughout the county, and telegraph offices are at all railroad points.

The topography of the county is rolling to comparatively level, and the elevation is from 375 to 600 feet above sea level. The general slope is to the east and to the Colorado River, which flows through the center of the county in a southeasterly direction. The gently rolling prairies in the northwest give way to the more rolling, sandy, timbered lands of the Susquehanna fine sandy loam to the east, near Elgin. This rolling area extends as far east as McDade, where it reaches the sandy divide of Norfolk fine sand, running in a southerly direction to the Colorado River and in a northward direction out of the county. In this northern section it constitutes a divide between the Brazos and Colorado rivers. The country to the west of this divide, including the northwest section of the county, is drained by Wilbarger, Big Sandy, and Piney creeks and their tributaries, all flowing in a southerly direction to the Colorado River. To the east of this divide and north of Paige, the slope is toward the Brazos River, while the eastern area south of Paige is drained by Gravelly and Pin Oak creeks and their tributaries, which also flow southward to the Colorado River. In the southern part of the county, a few miles west of Rosanky, occur broad areas of Norfolk fine sand, also constituting a divide, which is in line with that north of the river. The west and southwest quarter of the county, included between this divide and the river, is drained in an easterly direction by Walnut Creek and tributaries. These tributaries comprise Cedar and Alum creeks from the north and Elm, Sandy, and Piney creeks from the south. The slope of the extreme southern part of the county is to the south and southeast, with drainage through Borden, Prickly Pear, Grady, and Willow creeks, all emptying into the Colorado River.

The greater part of the county's population is of comparatively recent citizenship, and includes Americans, Germans, Swedes, Bohemians, Mexicans, and negroes. The first settlement was made about 1832, and the early population was practically all native-born Americans coming to the frontier from Missouri, Kentucky, Tennessee, Mississippi, Alabama, and the other old southern States. The rich natural resources of forest and soil offered inviting fields for the home seeker, and during the early settlement and later development, immigration took place both from the several States of the Union and from foreign lands, thus giving the county, within its seventy-five years of existence, a cosmopolitan population. A few Germans, English, and Irish were among the early settlers, coming direct from their native lands. The negroes came in large numbers after the close of the civil war, which time also marks the beginning of the influx of Mexicans, who have continued to come up to the present time.

A great majority of the Mexican population is composed of "peons," who, having escaped bondage, crossed the border into Texas. The various other nationalities living in the area have immigrated in part from the larger centers of the United States and in part from their native homes. Of the naturalized citizens, the Germans exceed in point of numbers and length of citizenship, and they can be found actively engaged in all lines of endeavor. The Bohemians and the Swedes are both industrious classes of people and much of the fertile farming land of the county is owned by them. The black prairies in the northwestern section of the county are owned largely by Swedes, their holdings extending almost to Austin. The southern section of the county around Rosanky is settled principally by Bohemians. Red Rock and Paige are German settlements. The negro and the Mexican population are well scattered throughout the entire area.

The county as a whole is fairly well populated, though the conveniences and benefits arising from railroad facilities and the productiveness of the soil determine largely the intensity of development. The stronger soils offer the greater reward for labor, and in consequence the Colorado River bottoms and the black prairie belt are the districts most thickly settled. The sandy hills, which extend in a southerly direction from the "Yegua Knobs" in the northern part of the county, ending in extensive areas of very gravelly hills in the central section, embrace a portion of the area that is extremely thinly settled. These gravelly areas can not be cultivated and the sand hills are unfitted for general farming. The present value of these hills is in the timber growth. The unimproved condition of the public roads is a strong factor in retarding a more general intensive development in the sections which are more distant from market centers. The county possesses an abundance of road material, however, and in time this will be utilized in improving roadways.

There are two systems of railroad crossing the county. Bastrop, the county seat, on the Missouri, Kansas and Texas Railway, with a population of 2,500, is located in the central section of the county, on the Colorado River. Smithville, in the southeastern section, with a population of 3,000, is also situated on the Colorado River. It is the junction point of the Missouri, Kansas and Texas Railway with a branch line extending to San Antonio and passing through Rosanky and Red Rock, two small towns in the southern and southwestern parts of the county, respectively. Elgin, in the north, has a population of 2,500, and here the Missouri, Kansas and Texas Railway and the Houston and Texas Central Railroad cross each other, the former running north and south and the latter east and west and passing through McDade and Paige, two small towns, with populations of 400 and 300, respectively, in the northeastern section of the county.

The Colorado River is bridged with steel structures at Bastrop and at Smithville. Several good fords and two ferries at convenient intervals afford ample accommodations for all travel, the river being fordable most of the year.

The agricultural interests of the county, as well as the commercial and industrial, are enjoying a substantial prosperity. The cotton losses sustained during the activity of the boll weevil resulted in the introduction of some new crops, with beneficial results. During the last two seasons the cotton crop has been little affected by the boll weevil and yields have been very profitable.

CLIMATE.

The latitude of Bastrop County is that of southern Louisiana and northern Florida, parallel 30° N. crossing near the center of the county. The climate is practically that of New Orleans, with less humidity, insuring healthful and pleasant climatic conditions.

The mean annual rainfall is 32.92 inches and the average annual temperature 67.4° F. January and February, the coldest months of the year, average approximately 49° F., with July and August, the warmest months, averaging about 83.5°. During the winter months very sudden changes in the weather occur, often giving a rapid fall in temperature of many degrees. These cold spells are known as "northers," on account of the direction from which they come and the accompanying cold winds. They are of short duration, however, and the temperature seldom falls to freezing point. However, occasional freezes occur of sufficient severity to prevent plowing, though cultivation can generally be carried on all the year round. Late frosts catch the fruit blossoms and early vegetables every few years, but a total failure of these crops has never resulted from this cause.

The following table, compiled from statistics of the Weather Bureau, shows the normal monthly and annual temperature and rainfall,

based on records covering a period of five years, from 1902 to 1906, inclusive. These records were kept at Taylor, Luling, and Austin, in Williamson, Caldwell, and Travis counties, respectively. There are at present no stations in Bastrop County. Taylor is a few miles north, Austin 15 miles west, and Luling 15 miles south of the Bastrop County area.

Normal monthly and annual temperature and precipitation.

Month.	Taylor.		Luling.		Austin.	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	° F.	Inches.	° F.	Inches.	° F.	Inches.
January.....	47.7	0.83	49.2	1.16	49.4	0.85
February.....	48.6	2.53	50.7	3.33	50.8	3.26
March.....	60.5	2.38	62.2	1.64	62.1	2.41
April.....	67.4	3.18	68.7	3.11	68.8	3.98
May.....	74.3	3.51	75.1	2.94	76	3.99
June.....	79.8	3.18	80.8	2.50	82.3	2.53
July.....	80.6	7.22	82.2	5.01	83.2	5.08
August.....	82.1	1.35	83.5	1.30	84.1	1.59
September.....	77.7	2.79	79.1	3.42	79.5	2.51
October.....	67.2	2.43	68.5	2.98	68.3	2.06
November.....	59.7	2.37	60.9	2.12	60.9	2.14
December.....	50.5	1.88	51.9	2.76	52.1	2.55
Year.....	66.3	33.65	67.7	32.27	68.2	32.85

The rainfall is fairly well distributed throughout the year and would, if properly conserved, accommodate the growing crops during any summer drought.

The following table, compiled as the preceding one, gives the dates of the first and the last killing frosts for the years 1902 to 1906, inclusive, and also the average dates for that entire period.

Dates of first and last killing frosts.

Year.	Taylor.		Luling.		Austin.	
	Last in spring.	First in fall.	Last in spring.	First in fall.	Last in spring.	First in fall.
1902.....	Mar. 6	Dec. 4	Mar. 6	Nov. 27	Mar. 6	Dec. 3
1903.....	Mar. 1	Nov. 17	Mar. 2	Nov. 18	Feb. 18	Nov. 18
1904.....	Mar. 4	Nov. 12	Mar. 4	Nov. 12	Mar. 4	Oct. 12
1905.....	Feb. 21	Dec. 3	Feb. 22	Dec. 4	Feb. 21	Dec. 4
1906.....	Mar. 20	Nov. 21	Mar. 20	Nov. 20	Mar. 20	Nov. 20
Average.....	Mar. 5	Nov. 23	Mar. 5	Nov. 22	Mar. 2	Nov. 17

AGRICULTURE.

The earliest settlers of the county made their homes in and around the site on which Bastrop now stands, where they found a very primitive agriculture carried on by Indians and Mexicans, the crops consisting of small patches of corn and vegetables. The food supply was

obtained principally from the forests and streams, which abounded in game and fish. The three earliest settlements were at Bastrop in 1832, at Cedar Creek about the same time, and at Perryville, better known as "Hog Eye," in 1838. Many of these settlers received a league of land each from the Government, of which they devoted small areas along the easily cultivated river bottoms to corn, wheat, rye, and vegetables, holding the greater stretches as pasturage for their stock. The establishment of homes by those who came to the frontier resulted gradually in a more sturdy agriculture, though the raising of cattle was the principal industry, and so continued for a long time. The valley lands along the river and the creeks were the first to be cultivated, as the homes of the settlers were placed in those localities where a supply of water was convenient. Ease of cultivation and a natural fertility were essentials for all cultivated areas. The growing of cotton, which in later years became the chief product of the county, was introduced soon after settlements were made, though its cultivation was very limited for many years. The first cotton crops of any extent were grown in the late forties and by men who owned slaves. Horsepower gins were used and the raw product was hauled overland by ox teams to the nearest markets—Houston and Port Lavaca, and later to Austin. In return for cotton the ox teams brought back provisions and other necessities. The lack of railroad facilities prevented any very extensive operations in cotton, though Austin became a close market and gave an impetus to an increased production of that crop. Corn and the other general farm crops kept pace with the agricultural development.

In 1869-70 the Houston and Texas Central Railroad, with its terminal at Brenham, the nearest railroad point to Bastrop, extended its line to Austin, passing through the northern section of the county from east to west and crossing the old San Antonio trail at Paige. This afforded a more ready means of marketing products and marks an era in the agricultural as well as the commercial life of the county. In 1887, the Missouri, Kansas and Texas Railway passed through the county from north to south, crossing the Houston and Texas Central Railroad at Elgin, and opening up the central and southern sections. These convenient transportation facilities resulted in greater agricultural development, which was also stimulated by increasing demands. The stock and cattle ranges gradually gave way to cultivated areas of cotton, corn, and other staple crops, thus making the county decidedly an agricultural community. Stock raising has been carried on continuously, even during recent years, though in limited ways.

The present agriculture consists in the raising of cotton as the chief money crop, with corn, wheat, oats, sorghum, melons, potatoes, various vegetables, fruits, berries, peanuts, some cowpeas, alfalfa, Johnson grass, millet, etc., in sufficient quantities to meet local demands. No

general system of growing crops in beneficial rotation has ever been adopted in the agriculture of the county, and little or no fertilizer has ever been used. The fertile alluvial soils of the stream bottoms and the productive black prairie clays, constituting the strongest soils of the area for general farming, have as yet suffered little if any deterioration on account of the one-crop system, but the lighter sandy soils of the rolling uplands are soon reduced to a low productiveness by the inconsiderate and continual cropping of cotton and corn. These lighter soils are better adapted to a variety of crops, such as fruits, truck, and probably tobacco, than they are to general farming. They give fairly good yields of cotton and corn, however, for two or three years. For these soils is recommended the addition of green manures. Systematic crop rotation, which includes a broadcast growth of cow-peas every two or three years to be plowed under after the fruit has been harvested by hogs or in other remunerative ways, would no doubt greatly increase the crop yields. The failure to care for and improve the cultivated areas of these light soils has been due to the abundance of cheap new lands which were naturally fertile and which could be more or less easily cleared for cultivation. It has resulted in the abandonment of areas after a few years' tillage. The improvement of these lands by means of proper cultural methods was sacrificed in the effort to obtain yields at the least expense. Probably such a practice was once sanctioned by economic conditions, but these soils now represent agricultural possibilities that merit the attention of progressive farmers in supplying the diversified demands of a growing country.

Cultivation is carried on practically along the same lines as it was years ago, except by some of the most progressive farmers, who have introduced modern farm machinery and other general improvements. Crops are still planted and matured with as little expense as possible. The preparation of the land for cotton and corn begins in January and February. The soil is broken 3 or 4 inches deep and left in ridges until the planting season, which is in late March. This treatment of land can not be upheld, as it allows free evaporation of the soil moisture for too long a time in a section where summer droughts sometimes seriously damage the crops. While it is true that the annual rainfall is sufficient to mature all crops when distributed through the growing season, a proper regard for the conservation of the late spring rains would guard against possible loss in unfavorable seasons. Deeper cultivation in preparing the soil, to render it retentive of moisture, and frequent shallow tillage during the growing season, especially following rains, to destroy capillarity by the formation of a dust mulch, would be of much benefit in overcoming the injurious dry seasons. The machinery used in planting, in passing over the ridges or beds, has a tendency to break them down considerably, leaving the seed about on an average ground level. Some

areas in the flat, poorly drained regions are best handled by ridge culture, but the tendency generally is for flat cultivation.

The most of the hired labor in the county is supplied by Mexicans and negroes, of whom many are found in all parts of the county. They are engaged by the month or by the year at an average wage of \$18 to \$20 a month. This supply of farm labor is usually sufficient to meet all demands, except during the rush of the cotton-chopping and cotton-picking seasons, when additional day labor is necessary. In such instances laborers are paid from 75 cents to \$1.25 a day, and the demand is often in excess of the supply. Occasionally this day labor is paid by piecework, which on an average amounts to about \$1 a day. Cotton choppers may receive so much per acre for their work and cotton pickers so much per hundred pounds of cotton picked, the price being generally about 75 cents an acre for choppers and from 50 to 75 cents a hundred pounds for picking. The apparently more attractive life of the industrial and commercial centers is drawing much of the labor from the farms, though as yet the labor question has not reached serious proportions.

The cultivation of the land is carried on in part by the landowner and in part by the tenant or renter through a system of limited tenure of the land and a division of crops according to the expenses incurred by the owner and by the tenant. When the owner furnishes the land, all work stock, the seed, and the house for tenant, he receives one-half of all crops; when he furnishes only land and house for tenant he receives one-fourth of the cotton and one-third of the grain crops. These are the popular terms on the share basis. Land is also rented on a cash basis, the tenant paying from \$3 to \$4 an acre, according to the productiveness of the land. The cash system is very popular and is, no doubt, the most advantageous. Cotton being the money crop, all landowners leasing land on a share basis insist on dictating the extent of that crop, with the result that the tenant is limited more or less in the matter of crop diversification. By the cash system he is free to grow such crops as he deems most profitable.

The census of 1900 gives the average size of farms in the county as 110.9 acres, with 37.6 per cent of these farms operated by the owners. The stronger soils, comprising the river bottoms and the black prairie clays, show a smaller acreage per farm than the less valuable sandy lands. Agriculture on the stronger soils and in the immediate vicinity of commercial centers is more intensive than in other sections of the county and land values are correspondingly high.

The following general suggestions would conduce to a stronger agriculture in the county; careful tillage methods looking to the conservation of soil moisture, a beneficial system of crop rotation, a study of adaptability of crops to special soils, and systems of permanent

soil improvement. The gradual growth of the larger trade centers, the ready marketing facilities, the advent of the destructive cotton boll weevil, and the introduction of new lines of remunerative agriculture are all combining to bring about a recognition of the wisdom of such changes.

SOILS.

Bastrop County presents an area with a diversity of soil types and of conditions sufficient to meet the demands of a most diversified agriculture. The alluvial soils or fertile bottoms along the Colorado River, which flows across the central part of the county in a southeasterly direction, consist of clays, silts, and sandy loams, while the uplands present types ranging from the productive heavy black clays of the gently rolling prairies to the loose and incoherent sands of the more rolling or hilly country. While it is true that many of the lighter soils of the area show a low agricultural value after their virgin productiveness is reduced by careless methods of cropping, these are by no means "waste soils," for the introduction of proper cultivative methods, together with some systematic rotation of crops insuring a necessary and continuous supply of organic matter, and the selection of crops suited to soils of this texture will bring them into much account as an asset in the agricultural resources of the county.

Twenty-three types of soils were established in the county, occurring as derivatives from the underlying geological formations, through the agencies of erosion, or as the result of the intermingling of the disintegrated material of different formations, or as alluvial material deposited by the river waters during periods of overflow, or as any of the above materials more recently influenced by modifying agencies, such as local conditions of rainfall, drainage, aeration, oxidation, erosion, etc.

The following table gives the names and areas of the several soil types shown on the accompanying map:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Susquehanna fine sandy loam.....	195,456	33.3	Lufkin gravelly loam.....	10,752	1.8
Norfolk fine sand.....	94,784	16.2	Bastrop sandy loam.....	7,080	1.3
Susquehanna gravel.....	50,880	8.7	Bastrop silt loam.....	6,080	1.0
Lufkin fine sandy loam.....	35,136	6.0	Lufkin sandy loam.....	5,312	.9
Houston loam.....	33,792	5.8	Lufkin fine sand.....	3,072	.5
Bastrop fine sandy loam.....	26,406	4.5	Wabash clay.....	2,432	.4
Houston gravelly clay.....	25,920	4.4	Wilson loam.....	1,664	.3
Wilson clay loam.....	17,536	3.0	Crockett loam.....	640	.1
Orangeburg fine sandy loam.....	17,216	2.9	Crockett clay loam.....	512	.1
Houston black clay.....	16,128	2.7	Swamp.....	320	.1
Bastrop clay.....	12,352	2.1			
Orangeburg fine sand.....	11,904	2.0	Total.....	586,944	
Meadow.....	10,880	1.9			

Three distinct geological formations appear in the county, causing the broad separation of the soils into three general groups, the areas in each group following the general trend of the underlying formation in a north and south direction. These series are affected by many modifying influences, which give rise to various subdivisions or individual types of soil. Along the northwestern border of the area, adjoining Travis County and extending almost to the Colorado River, is a narrow strip of black prairie clay representing the eastern boundary, in this section, of the stiff black clays found extensively in Travis County and derived from a series of unstratified calcareous clays and clay marls of Upper Cretaceous time, known as the Taylor marl formation. The weathering of this formation, which is often several hundred feet deep, gives rise to the type of soil known as the stiff heavy black prairie clay and classified as the Houston black clay. The Taylor marl formation extends across Travis County in a southerly direction and occurs extensively in Hays and Caldwell counties, as shown in the San Marcos sheet of the Soil Survey. In the southwestern part of Bastrop County and extending from Caldwell County is an arm of this calcareous material, giving several square miles of Houston black clay in that locality. In the neighborhood of Paige, in the northeast section, is found the western edge of what is known as the San Antonio prairie, where several square miles of the Wilson clay loam is mapped. On the crests and slopes of some of the highest ridges of the rolling prairie uplands, this calcareous material has been modified by the remains of old gravel deposits, probably the Uvalde of Neocene time, thereby giving rise to the type—Houston gravelly clay. The most extensive areas of this gravelly type are found in the western edge of the county, occurring on the higher ridges a few miles north of the Colorado River. A few small areas are found around Paige. To the east of this black prairie formation is the rolling, sandy, timbered belt. At the juncture of the black prairie clays and the light sandy soils is a rather broad gradation zone showing a soil resulting from the intermingling of material from the two formations, which soil is classified as the Houston loam. Extensive areas are found around Red Rock, and many small isolated areas of a calcareous material are found which have been so modified by the surrounding sandy types that they belong to the loam member of the Houston series. The Houston series is a very productive group of soils, and while careful cultivation is necessary to secure good tilth, these soils are considered the most desirable and strongest of the upland types for general farming.

In point of extent the predominating type of soil in the county is the Susquehanna fine sandy loam, occurring to the east of the Taylor marl formation. This type extends across the area from north to south in a broad belt, being intersected by the Colorado River bottoms near the center of the county and broken by large and small

areas of other types. The geological formation underlying this type is of Eocene Tertiary time and consists of sands, sandstones, and stiff clays. The weathering of this material results in giving the heavy red to reddish-brown and mottled clays underlying the sandy loam surface soil of the type.

Probably the Lignitic stage of Eocene time furnishes a part of the material constituting the Susquehanna fine sandy loam. Lignitic seams are found in the north-central part of the county, with outcrops of lignitic material along the Colorado River a few miles above Bastrop. This material being at some depth below the surface, however, is probably overlain by marine beds of later time. The surface material over the extent of the type is, in general, the same. Ferruginous masses and fragments of sandstone are common on the higher ridges, as are also waterworn gravels and pebbles. Modifying agencies of erosion, aeration, and oxidation have affected local detail characteristics of color, structure, and depth of this soil. Adjoining the more recent formation of Eocene time to the east, the Susquehanna fine sandy loam is very perceptibly influenced by the materials of that formation, especially by the gray mottled clays. There is less of the uniform red and more of the grayish red mottling in this position. The formation underlying this type broadens out in the southern part of the county, reaching as far west as the southeastern part of Travis County and extending southward across the eastern edge of the San Marcos area. Throughout this extent it gives rise to the Susquehanna fine sandy loam. This type of soil is easily worked and is adapted to a diversity of crops, a careful system of crop rotation being necessary, however, to secure sustained productiveness.

In the northern part of the county the Susquehanna fine sandy loam gives way to the sandier type, the Orangeburg fine sandy loam. There is mapped of this soil about 27 square miles. It is derived from the disintegration of sandy clay beds of the Claiborne stage of Eocene time. The type, in passing into Lee County, develops extensively, affording throughout its occurrence a very desirable and profitable soil for diverse agricultural practices.

In the northern half of the county and immediately to the east of the Susquehanna fine sandy loam and the Orangeburg fine sandy loam, beginning at the "Yegua Knobs" on the Lee County line and extending in a west-of-south direction to the gravelly hills adjacent to the Colorado River near Red Bluffs, is a series of sandy hills constituting a broad divide, which, no doubt, represents the beach of an ancient shore line. The occurrence of this deep sand gives rise to the type mapped as Norfolk fine sand. Probably a part of this type, occurring on some of the higher hills which are composed of a ferruginous sandstone, has been derived from the disintegration of that formation, the finer material having been washed out. Areas of

this material showing a surface soil of sand more than 20 inches and less than 3 feet deep, and underlain by a reddish sandy clay, were mapped as Orangeburg fine sand. The origin and texture of the two types is the same, the distinction being a question of depth of surface soil.

To the east of this sandy divide, and running generally southward, occurs a series of sands, fine sandstones, gravels, and grayish to dark grayish mottled clays. This formation belongs to the Jackson stage of Eocene Tertiary, and weathers into mottled yellow and gray impervious sandy clays which characterize the Lufkin series of soils. The general topography of this formation is more gentle than of the older formation to the west. On the most rolling areas are found the remains of old gravel deposits, which give the Lufkin gravelly loam type. Local conditions of better aeration and oxidation over the gravelly loam extent result in giving the subsoil a predominating reddish color, erosion often exposing this clay. On the more gently rolling to level areas is found the Lufkin fine sandy loam, while the lowest areas or depressions may give the Wilson loam.

It is in the northern section of this formation around Paige that the brownish-black clays or clay loams of the San Antonio prairie occur. This is not the typical black prairie soil, as it has been greatly influenced by the surrounding formation. There are areas of the Lufkin soils scattered through it, and it is between a body of this brownish-black clay loam and the Lufkin fine sandy loam that is found the only extensive area of Wilson loam. The formation of these sands, sandstones, and mottled clays extend into Fayette County and into the southern half of Lee County, where they give rise to extensive areas of the Lufkin soils.

The bottom lands of the Colorado River comprise a wide extent of valuable soils, all of which are derived from an old alluvial deposit. They occupy broad and level to gently rolling stretches, occurring as a series of terraces. The river valley is from 1 to 4 miles wide and is flanked on each side generally by a series of gravelly hills or ridges. Many places show a steep escarpment reaching to the river, with the broad bottoms on the opposite side, such a condition resulting from the meanderings of the river course. The gravelly hills skirt-ing the bottom lands show much evidence of river action. Rounded, waterworn gravel, pebbles, and flint cobbles, intimately mixed with the soil or cemented together with reddish to brownish clays, or gravelly beds resting on stratified material, show that these areas have been subject to water action. In the river bottom proper the highest terraces or swells represent the oldest river deposits. The red sandy clay material underlying the sandy loam surface soil no doubt represents material of the old Permian red beds reworked by the river, and the occurrence of this material gives rise to the Bastrop

sandy loam, the lightest general farm soil of the bottom types. The more level areas, with more fine material, a darker color, a heavier subsoil, and a closer proximity to the river, represent a later deposit. These have been mapped as the Bastrop fine sandy loam, which is probably the best of the alluvial soils. The Bastrop silt loam consists of a still heavier material and represents a deposition in areas of slowly moving overflow waters. The heaviest bottom-land type is the Bastrop clay, found generally in gentle depressions or hollows. It is no doubt eroded material of the black prairie regions, and constitutes the heaviest and strongest of the alluvial soils. Along the banks of the river occur at intervals strips of varying extent of deep sand or loamy sand, representing the natural levees and mapped as Meadow. Some of the smaller streams have also very narrow strips of this transported material, though the stream channels are generally sufficiently deep to carry all the rainfall without overflow.

The extensive areas of gravelly hills and ridges flanking the river valley contain too large a percentage of gravel, pebbles, and cobbles to have any agricultural value, the timber growth of pine and hardwood being the chief asset. These areas are mapped as Susquehanna gravel.

There exist several other, but unimportant, types of small extent, the result of conditions arising from influences which locally affect the character of the general material.

WILSON CLAY LOAM.

The soil of the Wilson clay loam has a depth of 6 to 10 inches and varies from a dark-brown to black clay loam or clay. It becomes very sticky when wet and contains varying amounts of gravel and pebbles. During dry weather it cracks badly, many of the crevices being from 3 to 4 inches wide.

The subsoil is a heavy clay to a depth of 36 inches and contains varying amounts of lime. It is usually of a dull dark-yellowish color and sometimes is streaked with black.

The type is located in two irregularly shaped areas, one in the northeastern part of the county in the vicinity of Paige, and the other in the southwestern part around Red Rock. It is locally known as "mesquite prairie." The surface of the type is so gently rolling as to allow ready cultivation. During very heavy rains it often happens that the greater part of the water sinks into the cracks formed during dry weather, only a comparatively small amount of water passing off through surface drainage channels. Areas needing artificial drainage, however, are not often found.

Wilson clay loam is a strong soil and has been under cultivation for several years. The principal crops grown upon it are cotton, corn, and oats. Both cotton and corn withstand long periods of

drought, since a large amount of moisture is stored up in the subsoil. Corn yields from 30 to 50 bushels and cotton from one-half bale to 1 bale to the acre. It is very probable that alfalfa would do well on this soil. A considerable part of the type is now used for pasture and meadow. Deep plowing is to be recommended.

The following table shows the texture of the soil and subsoil of the Wilson clay loam:

Mechanical analyses of Wilson clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16671.....	Soil.....	0.4	0.9	0.5	8.0	10.9	44.4	34.1
16672.....	Subsoil.....	1.1	1.6	.5	6.1	7.8	45.1	36.8

HOUSTON BLACK CLAY.

The soil of the Houston black clay, to a depth of from 8 to 14 inches, is a black to drab colored clay, containing some lime concretions and a high percentage of organic matter. The subsoil, to a depth of 36 inches or more, is a stiff, tenacious, brown to grayish-black clay, lighter in color than the surface soil and possessing a waxy feel. It contains a larger percentage of lime concretions than the overlying material and as the depth increases the clay becomes stiffer in structure and lighter in color.

This type is known as the "black lands" and constitutes the rich black prairie soil of the area. Being a heavy clay it is less easily handled than the lighter textured types, and much care is necessary to secure proper tilth. A careful cultivation for several years renders it a loose and friable soil, which becomes, however, very sticky when wet. If plowed too soon after a rain or when too wet, the soil breaks into clods which bake very hard on drying and which are broken only with difficulty. Unless continually cultivated, the surface bakes and cracks irregularly into blocks, the condition generally seen along the roadways. These cracks are often several inches wide and 2 to 3 feet deep, and during the winter season they afford a ready channel for the rainfall into the underlying subsoil, where the water is stored to be used by the crops during the dry summer months. The soil has good surface features, great natural productiveness, and is adapted to a wide range of crops, and when properly handled it responds as the strongest soil of the county.

The Houston black clay is found typically developed along the northwestern edge of the county and extends almost to the Colorado River. This narrow strip, covering 15 or 20 square miles, represents the eastern edge of the extensive black prairies immediately to the west.

The topography of the Houston black clay is gently rolling to rolling where it adjoins the more hilly country of the other types, and the natural drainage of the areas is good, with none of the bad effects of erosion. The undulating areas present rather wide valleys with an easy incline to the broad and rounded hills or swells. The stream courses, which are generally dry in summer, except during the rainy seasons, show no distinctly cut channels, as is seen in the other types of the area; still they afford ample outlet for excessive rainfall. The average elevation of this type is about 500 feet above sea level.

This stiff, heavy black prairie soil is derived in situ from the disintegration and weathering of calcareous clay and marl deposits, known as the Taylor marl formation, belonging to Upper Cretaceous time. The original material has a light-brown color, but weathers into a very productive black clay. On the more rolling areas or where the soil adjoins some of the gravelly types, it has been influenced by the intermingling of a small percentage of rounded gravel.

Scattered throughout the extent of this type are often found small areas, seldom exceeding an acre or two in size, that are locally known as "gall spots," because of the fact that cotton will not grow thereon. On these spots corn does not show any distress. The presence of alkali is still largely accepted as the cause of these local conditions, but investigation shows the trouble to be caused by a fungus attacking cotton, alfalfa, and other deep-rooted plants. The work of the Bureau of Plant Industry has demonstrated that deep plowing and frequent cultivation and the use of barnyard manure or green manure lets air into the soil and enables the crops to resist the disease. Grasses, grains, and corn are not affected.

The Houston black clay is adapted to general farming and ordinarily produces large yields. Cotton, corn, sorghum, and oats are the more extensively grown crops, while potatoes and garden truck are very successfully produced for local consumption. Cotton will average from one-half to three-fourths of a bale per acre, corn from 30 to 40 bushels, sorghum from 3 to 4 tons, and oats from 30 to 40 bushels. The last-named crop, however, is generally cut and fed to the stock in the straw. Better cultivation will, under favorable conditions, show much larger yields; cotton producing a bale to the acre, and corn from 40 to 60 bushels when not affected by drought. The type generally is very retentive of moisture and enough of the spring rainfall is stored in the subsoil to mature good yields despite the dry seasons. If properly seeded, alfalfa could probably be grown very successfully. The natural growth of this black clay is mesquite and prickly pear. It also supports a growth of native grass that makes excellent pasturage. The value of this land ranges from \$25 to \$75 an acre, according to local conditions.

The following table gives the results of mechanical analyses of both soil and the subsoil of this type:

Mechanical analyses of Houston black clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16669.....	Soil.....	0.1	0.6	0.8	16.9	12.0	40.0	28.8
16670.....	Subsoil.....	.6	1.0	1.2	11.3	6.7	46.9	32.0

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16670, 1.7 per cent.

HOUSTON GRAVELLY CLAY.

The Houston gravelly clay, to a depth of 12 inches, is a heavy dark-brown to black clay loam to clay, carrying a large quantity of rounded, waterworn gravel, varying in size from one-eighth to 3 inches in diameter, both in the soil and on the surface.

The subsoil, from 12 to 36 inches, is a stiff, compact yellowish-brown to grayish-black clay containing a small percentage of gravel. The gravel content of both soil and subsoil varies with the locality, the largest percentage being found on the crests of the ridges. Along the slopes and on the more or less rolling areas cultivation is comparatively easy, though the general roughness of the country and the presence of stones prohibit the free use of farm machinery.

The largest area of the Houston gravelly clay, comprising a few square miles, is found near the western edge of the county just to the north of the Colorado River, where it occupies the highest ridges of the black prairie area. The rolling black prairie lands to the north end in these higher ridges in the neighborhood of the river, where the remnants of old gravel formations give rise to the gravelly type. Several small areas are found south of the river and in the vicinity of Paige, in the eastern part of the county.

The topography of this type is rolling to very rolling, and this, together with the gravelly nature of the soil, insures ready drainage. The stiff clay subsoil, however, being very retentive of moisture, preserves enough of the rainfall for the maturing of crops during the summer season, droughts being no more severe than on the more level types.

The Houston gravelly clay represents areas where active erosion has been going on. The black prairie soil which overlaid the gravel formations, probably the Uvalde of Neocene time, was washed away sufficiently to expose these gravel beds, which in time were also worn away, leaving, however, a thin mantle resting on the underlying clays. These remnants of the old gravel beds have become mixed with the clayey material giving the present conditions. Much of the finer

material has been washed from the crests of the higher ridges to the hillsides or lower lying areas, leaving in these localities the most gravelly phase.

General farming is practiced, and when proper cultivation is carried on good yields are obtained. Cotton ordinarily produces from one-third to one-half bale per acre, and corn from 20 to 30 bushels. Some of the land, in the hands of careful farmers, will yield about three-fourths bale of cotton regularly, and from 25 to 40 bushels of corn per acre. A better yield of corn is had when a good rainfall is distributed throughout the growing season. Oats do well, producing from 25 to 40 bushels per acre, though this crop is generally fed in the straw. All the general garden vegetables are grown successfully for home use. The location of the type, its hilly topography, and its gravelly character render it less desirable than the rolling prairie.

The natural growth of the Houston gravelly clay is a forest of oak and cedar. The value of the land is from \$10 to \$30 an acre, according to local conditions.

The following table gives the results of mechanical analyses of the fine earth of both the soil and the subsoil:

Mechanical analyses of Houston gravelly clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16151.....	Soil.....	4.2	3.5	1.8	7.6	8.8	45.0	28.5
16152.....	Subsoil.....	1.8	2.2	.9	3.2	6.4	47.2	37.6

HOUSTON LOAM.

The Houston loam is a brown to grayish-brown loam 8 to 12 inches deep, underlain to 36 inches by a brownish to drab-colored clay subsoil, carrying a high percentage of silt, and some fine sand, and occasionally some gravel. The surface soil varies from a light loam to a clay loam, according to topography and to proximity with the light sandy soils or the heavy clay soil. The color also varies from grayish to brownish; on the crests of gentle elevations it may show a light-brown color, while the depressions or more level areas may be a gray to dark gray. The surface loam generally carries a high percentage of silt, and some organic matter. The subsoil, at lower depths, is quite stiff and is often of a mottled appearance, being streaked with reddish brown. As shown in road cuts and washes, it may have a much lighter color. When properly cultivated it is a loose, friable soil and is more easily handled than the Houston black clay.

The Houston loam occurs in the northwest section of the county as a narrow strip occupying a position between the black prairie soils

and the rolling sandy uplands. In the southwest, in the neighborhood of Red Rock, are found rather extensive areas running in a general northeast and southwest direction. These areas are of irregular shapes and sizes, but they hold a position which clearly indicates the original existence of much calcareous material, probably an arm of the Taylor marl formation extending from the main body into this section. The influence of the surrounding sandy formations has broken the uniform extent of that material and given rise to the irregular areas of Houston loam. Many small areas are found scattered throughout the county.

The topography of the type is gently rolling to rolling and the natural drainage is good, except in occasionally depressed areas where the condition can be more or less easily remedied by ditching.

The Houston loam, occurring as it does on the more rolling upland prairies between the heavy black clays of the Taylor formation of the Cretaceous period and the sandy, timbered soils derived from sands, sandstones, and clays of Eocene time, is a gradation type and represents the intermingling of the materials of these two classes of soils.

Much of the type is under cultivation and constitutes desirable land for general farming. The summer droughts occasionally injure the late-maturing crops, though good yields of cotton, corn, oats, and sorghum are produced. Potatoes and vegetables do well, though they are not extensively grown. Cotton will average about one-half bale per acre; corn from 15 to 30 bushels; oats from 15 to 30 bushels, and sorghum about 2 tons. Thorough and careful tillage, with a system of rotation of crops, would substantially increase the productiveness of this soil.

The approximate extent of the Houston loam is about 53 square miles. It has a value of from \$15 to \$35 an acre according to local conditions.

The following table gives the results of mechanical analyses of samples of both soil and subsoil of this type:

Mechanical analyses of Houston loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16149.....	Soil.....	0.2	2.2	2.1	10.3	18.5	55.4	11.3
16150.....	Subsoil.....	.6	2.6	1.6	8.1	16.5	40.9	30.2

SUSQUEHANNA FINE SANDY LOAM.

The surface soil of the Susquehanna fine sandy loam, which has a depth of from 8 to 16 inches, consists of a gray to reddish-brown fine sandy loam, containing generally a percentage of iron concretions and, where the type occupies the crests or slopes of hills, some

small gravel. In this position fragments of ferruginous masses are also common. The subsoil, to a depth of 36 inches or more, is a heavy red to reddish-brown clay and generally mottled at lower depths. The sand content of the soil varies in texture from medium to fine. The subsoil shows the mottled appearance at about 24 inches, though the heavy red clay may extend to 36 inches or more. There is no regularity in this color appearance of the subsoil, though generally the more uniform red color is found on the slopes or where better aeration and oxidation is possible.

The line of separation between the soil and the subsoil is quite distinct, and while the overlying sandy material may impart a low sand content to the immediately underlying subsoil, it quickly passes into the heavy clay. The loose, open structure of the soil, its rolling topography and good drainage render it easy of cultivation.

The Susquehanna fine sandy loam is the predominating soil type of the uplands and embraces approximately 305 square miles. It extends in broad limits across the center of the county in a northeast and southwest direction, being broken, however, by areas of other types and crossed by the broad bottom lands of the Colorado River near the center of the county.

The topography is rolling to hilly, affording good natural drainage. Much of the soil is subject to erosion, especially the more hilly sections, where is found also a lighter soil. The lower lying areas possess a larger percentage of the finer grades of material, this material having been washed down from the surrounding elevations. Erosion is sometimes quite severe on the hillsides, often washing away the sandy surface soil and exposing the subsoil.

Both the large and small streams, which are generally dry in summer, have cut rather deep channels through the underlying clays and washes may be frequently seen from 6 to 12 feet deep extending down the slopes.

The approximate elevation of this type is 500 feet above sea level over its entire occurrence. The rolling areas of the Susquehanna fine sandy loam are not very retentive of moisture and crops often suffer during the summer droughts, while the lower lying areas may not be so badly affected, as they receive and retain more of the rainfall and the drainage water from the higher lands. These summer droughts offer the chief difficulty in diversifying the crops to which this type of soil seems adapted; still, a proper attention to the conservation of soil moisture would greatly simplify this problem.

The Susquehanna fine sandy loam is probably derived from the clays of the Claiborne stage of Eocene Tertiary time. Outcrops of fine-grained sandstone and ferruginous conglomerate are found capping many of the higher hills, while fragments of these materials are found extensively scattered over the surface.

General farming is practiced on the Susquehanna fine sandy loam, cotton, corn, and oats being staple crops, while potatoes, fruits, melons, vegetables, and peanuts are grown for local markets and home consumption. No fertilizers are used on this soil, no system of crop rotation is practiced, and little attention is given to improvements. The soil is naturally productive, but with continual cropping the yields decline and when the point is reached where little profit results, new lands are brought into cultivation. Cotton is more generally cultivated than corn, the latter crop being confined to the lower lying bottom lands, where the conditions are more favorable. The average yield of cotton is from one-fourth to one-third bale per acre; corn, from 15 to 25 bushels, and oats from 10 to 20 bushels, though these are generally fed in the straw. Peanuts produce abundantly and are grown for local consumption and as pasturage for hogs. With a system of crop rotation, furnishing some organic matter to the soil, the productiveness of the type would be greatly increased and indefinitely maintained. The rotation of cotton, corn, and cowpeas, with the peavines plowed under, is recommended. The type gives excellent yields of potatoes, vegetables, melons, grapes, and peaches. All small fruits adapted to the climatic conditions would do well.

The culture of tobacco could probably be promoted over at least certain areas of this type. Where the soil material at lower depths has more or less the character of the Orangeburg subsoil, which appears to possess certain characteristics essential to the production of a desirable type of tobacco, the cultivation of this crop is a practical agricultural problem. The soil occurs rather typically developed throughout the central and southern sections of the county and is not considered generally as being especially adapted to tobaccos of very desirable qualities.

In its original condition this land supports a growth of hardwood, chiefly post and black-jack oak, with some pine in the central part of the county. It has a value of from \$4 to \$10 an acre. The cultivated areas sell for from \$10 to \$20 an acre, according to local conditions.

The following table gives the average results of mechanical analyses of both soil and subsoil of this type:

Mechanical analyses of Susquehanna fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16147, 16703.....	Soil.....	0.1	0.4	0.8	33.5	33.2	24.7	7.7
16148, 16704.....	Subsoil.....	.1	.3	.6	19.1	20.1	20.2	38.9

ORANGEBURG FINE SANDY LOAM.

The soil of the Orangeburg fine sandy loam, to a depth of from 6 to 15 inches, is a medium to fine grayish to reddish-brown loamy sand to sandy loam, containing some organic matter, many iron concretions, and often fragments of ferruginous sandstone. The subsoil, to a depth of 36 inches or more, is a red to orange-red sandy clay showing in many places a high clay content. Iron concretions also occur in the subsoil, which at lower depths rests upon horizontal beds of stratified clays. The more sandy areas, showing a surface soil from 20 to 30 inches deep, were mapped as Orangeburg fine sand. The loose, open structure of the soil and good natural drainage render it easy of cultivation, care being occasionally necessary to prevent erosion on some of the most rolling areas.

The type occupies, approximately, 10 square miles of country in the northern section of the county. Occasional small areas are found irregularly scattered throughout the adjoining types to the south. The topography is gently rolling to rolling and the drainage is good.

The Orangeburg fine sandy loam is derived from the disintegration and breaking down of beds of sandy clays of Eocene Tertiary time. It appears to be continuous with the formation giving rise to the Susquehanna fine sandy loam toward the south. The generally loose, sandy nature of the soil would indicate that much of the finer material has been transported from its original position. The hills and slopes show the sandiest phase of soil, while the areas adjoining stream courses generally present a more loamy texture, holding as they do much of the finer material that has been washed down from the higher elevations.

When first deforested and devoted to agriculture this soil produces good yields of ordinary farm crops. Continuous cultivation, however, without the application of any manures or the use of leguminous or other crops that could furnish at least organic matter to the soil, soon deprives it of its virgin productiveness. It is a soil not so very retentive of moisture, particularly on the ridges and slopes; still, a careful tillage and a system of crop rotation that would furnish organic matter in appreciable quantities would make it very well suited to the general farm crops. Especially is this true of the more level, lower-lying areas.

The type is naturally a loose, open, warm soil adapted to truck and fruits. Peaches do remarkably well, though they have never been grown on a commercial scale. Fruits, melons, potatoes, peanuts, and various vegetables could no doubt be grown very profitably.

This soil has been found to be well suited to the growing of tobacco in many sections of the country and could no doubt be used for this crop in this locality. The favorable climatic conditions might justify the extension of tobacco culture.

In connection with the material giving rise to the Orangeburg series of soils is a formation which weathers into the Susquehanna series, extensive areas of which occur throughout the central and southern portion of the county. Within the zone of transition from one to the other there is no clearly marked line of separation, the two series of soils presenting numerous characteristics in common. While the Susquehanna soils have not generally proven especially adapted to the cultivation of desirable qualities of tobacco, there are areas, as above mentioned, that could no doubt be utilized profitably in growing this particular crop.

Of the general farm crops cotton and corn are chiefly grown, cotton yielding from one-third to one-half bale per acre and corn from 15 to 30 bushels, depending on the rainfall during the growing season. The chief requirement of the soil is organic matter, and the planting of cowpeas every two or three years in rotation with the other crops would result very beneficially. The cowpeas should be plowed under after the peas have been harvested.

The Orangeburg fine sandy loam in its virgin state is worth from \$5 to \$20 an acre, and when improved from \$10 to \$30, according to local conditions.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16701.....	Soil.....	0.2	0.2	0.2	60.2	28.2	7.0	3.6
16702.....	Subsoil.....	.0	.0	.1	37.1	28.7	3.8	29.5

ORANGEBURG FINE SAND.

The Orangeburg fine sand, to a depth of from 18 to 36 inches, is a gray to grayish-brown medium to fine sand, generally loose and incoherent, though at times quite loamy. The subsoil generally is a red sandy clay, though where the surface soil extends to a depth of 30 inches it may be a clayey sand to 36 inches, at the same time showing a grayish-red color. The surface soil is a little darker in color for the first few inches on account of the presence of organic matter. This is more noticeable in the uncultivated areas, as is also the fact that the soil often becomes very compact. Cultivation of this type is comparatively easy, however, as the soil naturally has a loose, open structure, a rolling topography, and good drainage.

The Orangeburg fine sand occurs chiefly in the northeastern section of the county along with the Norfolk fine sand about 6 miles northwest of Paige, though many small areas are scattered about

irregularly in connection with the Orangeburg fine sandy loam. The undulations of the type are nowhere severe and cultivation can be carried on over the extent of its occurrence. Drainage is correspondingly good and only the lower lying areas adjacent to stream courses are subject to excessive moisture conditions. These areas are protected, however, by the stream channels, as they are quite deep and afford an immediate outlet for all excessive rainfall.

The type has the same origin as the Norfolk fine sand, the discriminating difference between the two being chiefly the depth of the surface soil. There may also be slight differences in color and structure. The Orangeburg fine sand is sometimes a grayish red, with a more loamy nature due to heavier material, and the depth of soil varies from 18 to 36 inches, while the Norfolk fine sand is a grayish light, loose, medium to fine sand and always 36 inches deep.

Like all open-structured sandy soils the virgin productiveness of the Orangeburg fine sand declines rapidly. When first cleared, cotton will yield from one-third to one-half bale per acre and corn from 20 to 30 bushels. Green manuring is essential for increased and sustained productiveness.

The type is better adapted to special lines of agriculture than to general farming; fruits, melons, potatoes, peanuts, and various truck crops are produced in abundance for home consumption, and they could no doubt be as successfully grown on a commercial basis. The value of this soil is from \$8 to \$25 an acre, according to local conditions.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Orangeburg fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16695.....	Soil.....	0.0	1.7	5.2	48.8	24.0	17.3	2.3
16696.....	Subsoil.....	.2	1.4	4.8	47.4	24.7	18.2	2.5

LUFKIN SANDY LOAM.

The soil of the Lufkin sandy loam, to a depth of from 24 to 36 inches, consists of medium to fine gray to brownish-gray sand to loamy sand. Some areas may be a loose and incoherent sand, similar in surface appearance to the Norfolk fine sand, while other areas may show a heavier structure, containing some finer material and approaching a sandy loam. The subsoil, which occurs at from 24 to 36 inches, is a mottled gray and yellow to gray sandy clay and is quite impervious. Occasional areas may show a subsoil streaked with red. The line of separation between the soil and subsoil is quite distinct,

though for a few inches the subsoil is more a clayey sand, quickly passing, however, into the impervious sandy clay. This is a light soil and easily cultivated.

The Lufkin sandy loam nowhere occurs in extensive areas, its appearance being more or less frequent in small areas in any of the sand or sandy loam types. It is found generally in the more level stretches or depressions where drainage is deficient, though not invariably in that position. Its occurrence is in the central part of the county, chiefly, and its extent is approximately 8 square miles.

This type is derived from the underlying formations, the lower lying areas, however, presenting material that has been brought down from the surrounding elevations. Appearing chiefly in the region of the Susquehanna fine sandy loam, the origin is from the sands, sandstones, and stiff clays of Eocene Tertiary time. A poorer aeration, due to position and the impervious nature of the clay subsoil, no doubt accounts for its dull yellow and gray mottled or solid gray color.

Some of the type is under cultivation, but the greater proportion of it still remains in its native state and supports a growth of post oak. Cotton and corn are the chief crops grown, cotton producing about one-third of a bale per acre and corn from 12 to 25 bushels. The type would show better results if drainage were properly handled and the soil given a system of crop rotation, including a growth of cowpeas every two or three years. It is better adapted to peanuts, melons, potatoes, and vegetables than to general farming. The growing of early truck on the lower lying areas is not recommended, as the colder air has a tendency to flow into these places. It has a value of from \$10 to \$20 an acre, according to local conditions.

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Lufkin sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16677, 16679.....	Soil.....	1.4	10.7	13.8	40.3	11.7	18.3	4.1
16678, 16680.....	Subsoil.....	1.2	7.8	7.7	27.3	7.7	19.3	28.6

LUFKIN FINE SANDY LOAM.

The soil of the Lufkin fine sandy loam, to an average depth of 15 inches, is a medium to fine sandy loam, containing in localities a small percentage of gravel. Both the texture and the color may vary to some extent in different positions. The fine sandy loam on the level stretches is characteristic, while the slopes or areas adjacent to streams may show a loamy fine sand. The presence of a

larger supply of organic matter, depending generally on topographic features, gives this particular soil a darker gray color. On the better drained and better aerated areas, where oxidation has been more active, the soil may have a reddish to grayish-red tinge. The surface material of this type varies in depth from 4 to 20 inches, though the average is about 15 inches. On the higher divides, in the north-eastern section of the county, where erosion has been active, the soil is only a few inches deep and shows a reddish color, while some of the lower lying areas may show a depth of 20 inches. The subsoil of this type is generally a stiff, impervious, mottled yellow and gray sandy clay, the sand content being from medium to fine.

There are variations in the color of the subsoil, due no doubt to local conditions of drainage, aeration, and oxidation. The more rolling areas of the Lufkin fine sandy loam will often show a stratum of dark reddish to reddish-brown sandy clay a few inches in thickness immediately underneath the surface soil. This stratum of subsoil immediately passes into the gray or mottled yellow and gray sandy clay. The uniform darker gray color is found in the more level stretches where drainage is defective and where the surface soil is from 10 to 20 inches deep. The line of separation between the soil and the subsoil is generally quite distinct. Cultivation over the type is comparatively easy, except on areas of poor drainage.

The Lufkin fine sandy loam is found only along the eastern edge of the county, where it occurs irregularly, often extending as finger-like projections back into the county along the more level or valley-like depressions carrying stream courses. The topography of the type is gently rolling to level, with the rolling areas generally adjacent to other types of soil. There seems to be a gradual decline to a more level country as the type passes out of the county. Drainage over a great part of the areas is very good, as the topography is sufficiently rolling to prevent water-logging. The more level areas, however, would be benefited by open ditches, for the excess of moisture due to heavy rainfall is likely to be held in the soil by the impervious clays beneath. Though this soil is fairly retentive of moisture, where drainage is good crops often suffer from drought during the summer months. The moisture supply, which is generally drawn from the clays beneath by crops during dry seasons, is greatly reduced by the impervious nature of the subsoil.

The Lufkin fine sandy loam is derived from the weathering of sands, sandy clays, and shaly clay formations of the Jackson stage of Eocene Tertiary time.

For general farming the Lufkin fine sandy loam gives fair yields, cotton producing from one-fourth to one-half bale per acre and corn from 12 to 25 bushels. A large percentage of the type is still in its virgin state, supporting a timber growth of post and black-jack oak. When

first cultivated the soil is productive, but its fertility is soon reduced under the continual cultivation of cotton and corn. Peanuts do well, though they are grown only for home consumption and as pasturage for hogs. Fruits, melons, potatoes, and vegetables could no doubt be grown very profitably.

In the production of crops on this type of soil, the addition of organic matter, supplied as stable manure or as green manure, would result very beneficially. It has a value of from \$10 to \$30 an acre according to local conditions, the average prices being about \$15.

The following table gives the average results of the mechanical analyses of both the soil and subsoil of this type:

Mechanical analyses of Lufkin fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16248, 16687.....	Soil.....	0.7	1.2	1.0	39.4	22.2	29.7	5.4
16249, 16688.....	Subsoil.....	.3	1.1	.4	16.8	10.4	27.1	43.3

LUFKIN GRAVELLY LOAM.

The Lufkin gravelly loam is composed of 1 inch to 14 inches of fine earth, gravel, pebbles, and stones. The fine earth is chiefly a medium to fine gray sand, though in some instances it may be much heavier. The color may also be a reddish to yellowish gray where the subsoil is near or at the surface. The gravel content is always high and may be on the surface, in the surface soil, or from 6 to 10 inches beneath the surface. In this last position, the appearance of the type is similar to the Lufkin fine sandy loam. It occurs generally on the more level lower lying areas and is no doubt due, at least in part, to material that has been transported from the higher elevation and deposited over the gravel. The subsoil, where borings could be made or where it could be seen along washes, is a heavy grayish to yellowish or reddish sandy clay, the latter color predominating. Local spots are found where erosion has removed the finer materials, leaving the clay subsoil supporting the rounded rock fragments.

The type occurs along the eastern side of the county, associated with the Lufkin fine sandy loam, many areas of varying extent being mapped both north and south of Paige. It occupies generally the higher hills between the stream courses, though it has no regular occurrence. Areas may extend even to the streams or over stretches that are comparatively level. The type is of little agricultural value and, except in a few instances where the gravel content is sufficiently low to permit cultivation, it supports a timber growth of scrubby oak and is utilized as pasturage. A few of the more level areas are

cultivated with fair results. The topography is rolling to hilly and drainage is exceptionally good.

The soil is derived from sandy clay beds and shaly clays of Eocene Tertiary time. The rounded, waterworn gravel would indicate it to have been influenced by water action. Its position in relation to the sandy divide immediately to the west would support the theory of its having been an ancient shore line. The average yield of cotton is from one-fourth to one-half bale per acre, and of corn from 12 to 20 bushels. The type has a value of from \$5 to \$20 an acre, according to local conditions.

The following table gives the results of mechanical analyses of fine-earth samples of both the soil and the subsoil of this type:

Mechanical analyses of Lufkin gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16250.....	Soil.....	5.3	4.0	1.1	10.4	13.1	57.5	8.5
16251.....	Subsoil.....	2.7	1.2	.2	1.9	2.8	39.5	50.7

LUFKIN FINE SAND.

The Lufkin fine sand, to a depth of about 8 inches, is a grayish fine sand to loamy sand, containing some organic matter, and underlain to a depth of 30 inches by a lighter, grayish, loose and incoherent fine sand to loamy sand, which in turn is underlain by a mottled gray and yellow impervious sandy clay to a depth of 3 feet. Areas of the type were encountered where the loamy sand extended to a depth of 3 feet or more, with the characteristic clay occurring at lower depths. Occasionally the surface soil contains a noticeable quantity of small gravel.

No extensive areas of the type were mapped. Several small bodies covering approximately 2 or 3 square miles were encountered, generally at the juncture of the rather level Lufkin soil with the more rolling Susquehanna fine sandy loam.

The topography is gently rolling to comparatively level and the drainage is generally good, though in several instances the type occupies depressions where drainage is poor. All such areas are uncultivated and support the native timber growth of scrubby post oak and black-jack. In the event of cultivation open ditches will be necessary to relieve the soil of excessive water during seasons of much rain. This soil is partially under cultivation and fair yields of cotton and corn are produced. Being a light soil, it is especially adapted to fruits, potatoes, peanuts, melons, and vegetables. These crops would no doubt do well. Like all light sandy soils, it is readily

reduced in productiveness and should be treated with crops affording a supply of organic matter. Cowpeas plowed under would increase the yields. This land commands a price of from \$10 to \$20 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type. The clay subsoil was encountered at 30 inches and an analysis of this would doubtless have been similar to the subsoil of the Lufkin fine sandy loam.

Mechanical analyses of Lufkin fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
16683.....	Soil.....	0.1	0.7	0.9	57.0	16.1	22.5	2.8
16684.....	Subsoil.....	.2	.8	.8	54.3	19.4	18.4	5.5

WILSON LOAM.

The soil of the Wilson loam, to a depth of 9 inches, is a heavy dark-gray loam, containing a small percentage of fine sand and some organic matter. The subsoil is a mottled red, yellow and gray or drab clay, grading into a stiff, dirty-yellow clay containing a perceptible quantity of fine sand. The type is quite heavy and must be handled with some care to insure a good tilth.

It is found in the eastern part of the county, in a single area, some 2 miles northwest of the cornering of Fayette, Lee, and Bastrop counties. It has an extent of about 2 square miles. The type has a very gently rolling to level topography and occupies a position between the Houston black clay and the Lufkin fine sandy loam. Drainage is good, except on the more level areas where open ditches would result beneficially.

The soil is no doubt a gradation type between the formation underlying the Houston black clay and that underlying the Lufkin fine sandy loam. The surface soil possesses characteristics which would evidence a mantle of the formation giving the Lufkin soils to have been placed over the formation giving rise to the Houston black clay, the subsoil showing much resemblance to the subsoil of the black clay type.

The Wilson loam is more or less easily cultivated and very productive, cotton producing from one-half to three-fourths of a bale per acre and corn from 20 to 40 bushels. Cotton is the chief crop and is grown without the use of any fertilizers. The type would no doubt produce good yields of all crops adapted to the climatic conditions. The uncultivated areas support a natural growth of elm, mesquite, and post oak and offer good pasturage of native grasses. The land is valued at about \$30 an acre.

The following table gives the results of the mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Wilson loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16681.....	Soil.....	0.3	0.7	0.4	12.7	22.0	46.3	17.2
16682.....	Subsoil.....	.4	.5	.4	7.9	12.2	42.0	36.2

NORFOLK FINE SAND.

The Norfolk fine sand consists of about 7 inches of loose and incoherent gray to whitish-gray medium to fine sand, underlain by a material of practically the same structure and texture, but showing a yellowish-gray color. The organic matter contained in the first few inches gives the surface soil a grayish hue. This sand is always over 3 feet deep. On the more level areas the soil becomes quite compact, as is true of the entire type when wet. The most of the soil is in its virgin state, and supports a native growth of scrubby post and black-jack oak, with a fair grade of pine growing on the southern areas.

The Norfolk fine sand is found scattered throughout the central section of the county and in the south-central section around Rosanky. There is also a rather broad area in the neighborhood of Sayersville. It is found extensively and almost continuously as a stretch of sand-hills several miles broad and extending in a southerly direction as a divide from the "Yegua Knobs" in the north almost to the Colorado River, where it gives way to a series of gravelly ridges or hills which skirt the river valley. In the southern section, around Rosanky, the extensive areas show a trend of direction in line with the areas north of the river. The entire topography is more or less rolling and drainage is excellent. It is fairly retentive of moisture and when first cleared produces fair yields of cotton.

The Norfolk fine sand is of early Tertiary time and no doubt represents the sandy beaches of ancient shore lines. The long subjection to weathering has probably affected these sands, though there is no evidence that a great part of the type has ever been less loose and incoherent than to-day. Some areas of the type, however, hold such a relation to the underlying material that there can be little doubt that it is a derivative. These areas occur on hills or ridges which are composed of a fine-grained sandstone. The finer material resulting from the weathering of this sandstone has been washed to lower elevations, leaving the loose and incoherent sands as they are found to-day.

Much of this type might be profitably cultivated to fruits, melons, grapes, and vegetables for early market, the addition of much organic matter, either as stable or green manure, being of course essential. The available supply of moisture in this soil is greatly conserved by the natural sand mulch which exists during the dry seasons, evaporation being greatly checked. Watermelons do well and many are shipped yearly to distant markets. General farming is limited over the type; only a few areas occupying valleys and containing somewhat more fine material are devoted to cotton, corn, and sorghum, and here with only fair results. This soil has a value of from \$4 to \$12 an acre.

The following table gives the results of mechanical analyses of samples of this type:

Mechanical analyses of Norfolk fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16601.....	Soil.....	0.1	0.3	10.3	73.6	7.4	6.9	1.1
16602.....	Subsoil.....	.1	2.9	8.9	73.8	7.1	5.9	.8

SUSQUEHANNA GRAVEL.

The Susquehanna gravel, to a depth of from 6 to 20 inches, consists of sand, gravel, and cobble stones intimately mixed together and carrying a noticeable quantity of the finer grades of material. The gravel content is always high and the type has at present little value for agricultural purposes, save as timber land and pastures. The subsoil is generally a heavy red sandy clay, which at times, however, may show a brownish color. It also may contain beds of rounded gravel which usually occur from 2 to 20 feet below the surface. These beds, cemented together with the heavy red clay, may be several feet thick.

Many areas of varying extent are found where the finer material has been washed from the surface, leaving the stones resting on the underlying clays. Such areas constitute the gravelly clay phase of the type. The surface material of this phase may often show from 2 to 4 inches of fine earth and gravel, though generally erosion has been sufficiently effective to remove most of the fine material. Like the type, this phase has little agricultural value, except possibly over a very few small areas where the gravel content is sufficiently low and the topography sufficiently level to permit cultivation. There is another distinct phase of the Susquehanna gravel which consists of 3 feet or more of coarse to fine sand intimately mixed with rounded gravel, the fragments of varying sizes, though seldom exceeding three-fourths to 1 inch in diameter. This material rests on a red clay foundation and occurs in one small area adjacent to the river in the southeastern section of the county and in several small areas in the same position in the

western section. It occurs in the immediate vicinity of the junction of the bottom lands with the uplands. This phase has little agricultural value and occupies about 2 square miles all told.

The occurrence of the type is almost wholly on the high, rough ridges which flank the course of the Colorado River and often extend several miles back from the valley. The extensive areas show numerous small valleys threading their ways among the many ridges and hills, and it is in the lowest elevations of these valleys that is found the sandiest surface soil, as the sands and finer material have been washed to these positions from the ridges and slopes.

The Susquehanna gravel represents material that has been re-worked by river action in early days. The abundance of rounded gravel indicates a rolling due to water action, and the material was no doubt brought down from higher elevation and deposited along the course of the river with much of the finer material. Erosion has greatly influenced the original conditions, giving rise to the present aspects of the areas.

The chief value of the entire type is the timber growth of hard-wood and pine growing thereon, much of which is being handled on a commercial scale. The land has a value of from \$4 to \$30 an acre, though occasional areas supporting a better grade of timber may sell at a much higher price.

The following table gives the results of mechanical analyses of the fine earth of soil and subsoil of the Susquehanna gravel:

Mechanical analyses of Susquehanna gravel.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16252.....	Soil.....	3.6	2.6	1.5	43.7	19.3	24.2	5.2
16253.....	Subsoil.....	.8	1.5	.4	9.4	8.9	16.8	61.5

BASTROP CLAY.

The Bastrop clay to a depth of 6 to 10 inches is a dark-gray clay loam to heavy clay, underlain to 36 inches by a dark-gray to dark-brownish compact and plastic clay. Both soil and subsoil contain large amounts of silt and some organic matter. This type represents the heaviest soil of the Colorado River bottoms, being heavier in the depressions or along slightly depressed stream courses, which extend from the uplands to the river channels. When wet, the soil is very sticky and it bakes quite hard on drying, necessitating a careful and attentive cultivation in order to secure the best results. It should not be plowed too soon after a rain or when too wet, for in that condition it breaks into clods which bake very hard, thus preventing a

desirable tilth as well as diminishing the productiveness. It can not be plowed when very dry, as it is too hard. Continual cultivation at the proper time renders it a friable soil of excellent tilth, the heaviest phase being the most difficult to handle.

The type is an alluvial soil and occurs irregularly in areas of varying sizes along the Colorado River bottoms. The topography is comparatively level, with occasional swells or gentle depressions, and the drainage is not exceptionally good. Crops are seldom damaged, however, by reason of excessive moisture. The gentle slope toward the river affords an easy flow for any excessive rainfall. Some of the type is subject to overflow, though no apprehension is felt from this source over the cultivated areas. The depressions or level stretches are greatly benefited by surface ditching.

The Bastrop clay is derived from material which no doubt represents the finer silt and black clay of the prairie uplands, which have been eroded and washed into the river and deposited from the slowly moving waters during seasons of extensive overflow. It contains much organic matter, and is probably the strongest soil of the bottom types. General farming is practiced over the type, cotton, corn, and sorghum being the chief crops grown. Cotton produces from one-half to three-fourths of a bale per acre, corn from 25 to 50 bushels, and sorghum from 1½ to 2½ tons. Small areas of the type are given to alfalfa, which seems to do fairly well. It is better suited for corn than for cotton, cotton showing better returns on the lighter type of the bottom soils. This land has a value of from \$20 to \$40 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Bastrop clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16153.....	Soil.....	0.0	0.6	0.4	2.9	7.5	59.2	29.5
16154.....	Subsoil.....	.2	1.0	.4	6.6	10.8	50.8	31.1

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO₃): No. 16153, 4.63 per cent; No. 16154, 15.75 per cent.

BASTROP FINE SANDY LOAM.

The Bastrop fine sandy loam consists of 6 to 12 inches of dark-brown medium to fine sandy loam, underlain by a brown fine sandy clay which becomes lighter in color and heavier in texture as the depth increases. Both the soil and the subsoil contain varying quantities of silt, the surface soil often approaching a silt loam. On the more level or slightly depressed areas a heavier texture is found, while the gentle swells or terraces present a lighter phase.

This is one of the most extensive types found along the Colorado River. Having a rather loose structured surface soil, with very good drainage and being little subject to overflow, it is easy to cultivate and a very desirable soil for general farming and trucking. In places the areas run to the river front in a gradual decline, and overflows often occur in these particular places, but generally the river channel has been cut from 20 to 50 feet below the surface, thereby preventing the possibility of extensive inundations. Only once or twice in the memory of the oldest inhabitants have the bottoms in general been flooded.

The topography of the Bastrop fine sandy loam is comparatively level, with swells and depressions that are characteristic of old river bottoms. The drainage is generally good, with some depressed areas, however, demanding surface ditching.

The type is an alluvial soil, having been deposited by the river waters. The heavier clay subsoil no doubt represents the finer material that was originally taken into suspension while the river was cutting its channel through the hills above, and deposited over the broad lowlands during flood time. Later inundations have deposited the sands and silts forming the surface soils.

The Bastrop fine sandy loam is one of the most productive river-bottom soils, and adapted to a wide range of crops. It is quite retentive of moisture, though crops suffer sometimes from drought. While this condition can be remedied to some extent by the adoption of proper cultivative methods looking to the conservation of the soil moisture, it can not be so relieved for the extensive growing of truck. Its position makes possible a feasible plan of irrigation, however, which would result in attaining the highest possibilities of agricultural development. Cotton produces from one-half bale to 1 bale per acre, corn from 35 to 60 bushels, and sorghum from 2½ to 4 tons of forage. Oats give a hardy growth and are generally cut and fed in the straw. Alfalfa is grown on a limited acreage and gives very profitable yields. Pecans are indigenous to the soils of the Colorado River bottoms and no doubt their production on a commercial basis would become very profitable. This type is valued at from \$35 to \$70 an acre, according to location and local conditions.

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Bastrop fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16315, 16666.....	Soil.....	0.1	2.2	4.4	28.8	19.5	33.5	11.1
16316, 16666.....	Subsoil.....	1	1.8	3.3	20.4	19.7	32.9	21.3

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO₃): No. 16666, 6.5 per cent.

BASTROP SILT LOAM.

The Bastrop silt loam is a heavy brown silt loam 12 inches deep, underlain to a depth of 36 inches or more by a brown silt loam to silty clay, quite compact and heavy and somewhat darker in color than the surface soil. Both the soil and subsoil often show an abundance of small shell fragments, which occasions the local name of "shell lands." This is the second heaviest bottom type and generally occupies a position adjacent to the stream, or on rather level first terraces. The type when uncultivated becomes very compact and on drying cracks slightly. When properly handled, however, it is a loose, friable soil, very productive and desirable for general farming. Some small areas occurring along the immediate overflow lands are utilized for pasturage, as crops are easily flooded and damaged. Most of the soil is above the overflow mark and has very good drainage. Cultivation is comparatively easy.

This is an alluvial soil and represents deposits of silts and clays laid down during seasons of overflow. Occasional spots are found showing beds of sand at from 2½ to 5 feet below the surface, indicating that the silt and clay have been deposited over sandy material laid down by the river waters at an earlier stage.

The Bastrop silt loam is devoted chiefly to the growing of cotton and corn; cotton producing from one-half to 1 bale per acre and corn from 30 to 50 bushels. Oats are produced to some extent but very few are thrashed. Several small areas are given to alfalfa, which seems to be doing well, and no doubt this crop could be successfully grown over a large part of the type. Melons and potatoes give excellent yields. Pecans are indigenous to this type, as well as to the other bottom soils. While the soil is naturally productive and gives good returns, much larger yields could be secured with more attention to cultivation and improved methods generally.

The largest body of this soil is found in the western edge of the county and extending back for several miles along the river valley. It has a value of from \$30 to \$60 an acre.

The following table gives the results of the mechanical analyses of both the soil and subsoil of this type:

Mechanical analyses of Bastrop silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16238.....	Soil.....	0.2	0.4	0.1	0.4	8.1	79.3	12.1
16239.....	Subsoil.....	.0	.3	.0	.5	12.9	72.0	13.9

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16238, 21.60 per cent; No. 16239, 25.70 per cent.

BASTROP SANDY LOAM.

The Bastrop sandy loam to a depth of from 10 to 24 inches is a grayish brown to reddish-brown light sandy loam. The sand content varies from coarse to fine with the medium to fine texture predominating. The subsoil to 36 inches is a reddish to dark-reddish sandy clay, the lighter color occurring on the more elevated and better drained areas.

The type is found irregularly over the river bottoms, occupying the higher swells or last terraces as the bottoms give way to the uplands. Adjacent to the uplands the structure of the soil is looser and the subsoil presents its lightest color, being a red sandy clay. There are several comparatively level areas of the type which run to the edge of the river, ending in a steep escarpment from 25 to 60 feet above mean water level. This is clearly defined at Smithville, where the river has cut a deep channel, and the bluff on the south, rising abruptly some 60 feet, reaches the level bottom lands, which extend from the river a mile or more, giving an extensive area of Bastrop sandy loam. The depressions therein, however, may show areas of Bastrop clay or Bastrop fine sandy loam. The topography of the type in general is very rolling and drainage is good. The soil being loose and open textured, cultivation is quite easy.

This type of soil is the oldest of the alluvial bottoms. Occupying as it does, the highest swells and terraces of the alluvial area, much of the finer material has been washed to lower elevations, leaving a more open-structured and sandier surface soil. The red sandy clay subsoil no doubt represents material of the old Permian Red Beds, which has been reworked by river action.

The Bastrop sandy loam is adapted to the cultivation of cotton and corn, though corn gives better results on the lower types. Cotton produces from one-half to three-fourths of a bale per acre and corn from 25 to 35 bushels. The type is especially well adapted to the cultivation of truck. Small fruits, grapes, melons, sweet and Irish potatoes, and various vegetables can be grown on a commercial scale. Many small areas in the neighborhood of Smithville are devoted to these crops to supply in part local demands.

The addition of green manures and stable manures is essential for any maintained productiveness. This is the lightest of the alluvial soils and occasionally shows 3 feet of mellow sandy loam material. It is a warm soil and capable of being brought to a high state of productivity. It carries a value of from \$25 to \$75 an acre, depending on location and local conditions.

The following table gives the results of the mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Bastrop sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16661.....	Soil.....	0.2	3.8	10.3	43.1	16.5	18.8	6.3
16662.....	Subsoil.....	1.0	4.0	6.0	26.4	16.3	23.1	22.4

CROCKETT LOAM.

The Crockett loam, to a depth of from 8 to 12 inches, is a dark-gray loam to clay loam, quite heavy and containing some fine sand, organic matter, and occasionally a small percentage of rounded, waterworn gravel. The subsoil, to a depth of 36 inches, is a mottled yellow and gray and red sandy clay. The sand content is from medium to fine, and the red color may be in streaks. The soil is easily handled, shows a good tilth, and is at the present time practically all under cultivation.

Its occurrence is in the eastern section of the county, in three small areas, approximately 1 square mile in extent. It occupies comparatively level slopes adjoining stream courses, though the decline to the stream is sufficient to insure good drainage.

The type shows evidence of having been derived from the intermingling of some of the Houston black clay material of that section with the surrounding types. Probably small isolated areas of the material constituting the old San Antonio prairie, which have been greatly modified by the surrounding formations, are represented by the appearance of these small areas of Crockett loam. The type is very closely related to the soil mapped as Wilson loam.

The Crockett loam is a very productive soil and is devoted to the cultivation of cotton and corn. In crop yields it has practically the same value as the Wilson loam.

CROCKETT CLAY LOAM.

The soil of the Crockett clay loam, to a depth of from 8 to 12 inches, is a dark reddish-brown clay loam, containing some rounded gravel, iron concretions, and fragments of rock. The surface soil is not uniform in color, but has a spotted appearance. The subsoil is a mottled red, yellow and drab or gray clay loam to clay, containing, as does the soil, rounded gravel, fragments of rock, and an appreciable percentage of fine sand. The rock fragments found in both the soil and the subsoil are probably an impure limestone or sandstone carrying iron.

The type, though not easily cultivated, is a rather strong soil and gives good yields. It occurs in a single area in the east-central sec-

tion of the county, just south of Cottletown settlement, where it occupies well-rounded knolls and gentle slopes. Drainage is good. The type is surrounded by various sandy soils with a small area of Wilson clay loam capping a level-topped hill directly in line with its occurrence. This soil is no doubt derived from some calcareous material which has been greatly influenced by the surrounding formations. It is devoted to the general farm crops with good results.

WABASH CLAY.

The Wabash clay consists of a dark-brown to black clay loam to clay 12 inches deep and underlain to 36 inches by a stiff heavy clay of somewhat lighter color than the surface soil. The only area mapped is in the western section of the county, where it occurs as a narrow strip along the banks of Cedar Creek. The surface is comparatively level, with gentle swells and depressions. These depressions often hold water after rains, but the type is not subject to overflow.

The type is alluvial in origin and is derived from the clay and silt that have been washed from the black prairies into the creek and deposited along the flat areas adjoining the stream course. The soil contains much organic matter and is devoted to the growing of the general farm crops with good results.

This soil is a continuation of that mapped as Yazoo clay in the Austin area, its extent in this county being so limited as to make it of very little importance.

MEADOW.

The type mapped as Meadow includes soils varying in texture, color, and structure, which occupy narrow marginal strips along some of the smaller stream courses of the area, and occur at intervals along the course of the Colorado River. The soils are composed entirely of material that has been washed down from the surrounding elevations and material transported by drainage waters and stream action. While this type varies in characteristics, it is principally of a very sandy material, generally over 3 feet deep. The types of soil in the immediate vicinity determine largely the character of the material found along the banks of the stream.

Comparatively little of this type is overflow land, the stream channels having been cut sufficiently deep to prevent overflows even during seasons of excessive rainfall. A classified separation of this transported material was impossible, and it was only on the more extensive areas, which presented some uniformity, that it was attempted. The type is in a few instances a clay, or a loam, but generally it consists of a sand to a sandy loam. In almost every instance along the Colorado River it is a sand to a loamy sand, occupying the immediate overflow land and deposited as natural levees by the river waters.

None of the type along the river is cultivated, even though its position may now be above the high-water mark. It is utilized as pasturage, affording a luxuriant growth of native grasses. A part of the type along the smaller streams is under cultivation and gives good yields. These areas are usually an extension of the immediate overflow land and the soil is properly Meadow.

The type being variant in many features is classified broadly, position and manner of formation being the chief factors in making the separation. The cultivated areas are quite productive, devoted to the growing of cotton and corn generally, and command a value of about \$25 an acre.

SUMMARY.

The Bastrop County area, comprising 917 square miles, is situated in south-central Texas. It is almost wholly an agricultural community, showing, however, a few industrial enterprises in coal mining, brickmaking, and lumber. It has a cosmopolitan population and a sound agricultural and commercial prosperity, with Bastrop, Elgin, and Smithville as the chief centers. The elevation of the area is from 375 to 600 feet above sea level and the general topography is rolling. Some local areas are quite hilly, however, while others are comparatively level. Drainage is generally good.

The intensity of settlement throughout the county is determined largely by the productiveness of the soil and the convenience of market facilities, though most of the area is fairly thickly settled. The average size farm is about 110.9 acres. The uncultivated lands, which are mostly untillable, are utilized as pasturage for stock, though stock raising has ceased to be an extensive industry.

Two systems of railroad traverse the area, the Houston and Texas Central, from east to west in the northern part, and the Missouri, Kansas and Texas from north to south through the central part. These roads afford transportation facilities sufficient to meet all demands.

The climate is equable and mild, being subject to the moderating influences of the Gulf breezes. The average annual rainfall is about 33 inches and is fairly well distributed throughout the year, though occasional droughts occur during the summer months. Irrigation is not practiced, but is feasible over the extent of the Colorado River Valley. Most of the small streams are generally dry in summer, necessitating the collection of the winter rains in reservoirs, or "tanks," for use of the stock during the dry seasons.

The chief agriculture of the area consists in the production of cotton, with corn, oats, sorghum, fruits, melons, potatoes, cowpeas, alfalfa, and various vegetables grown in sufficient quantities for local demands. Large quantities of watermelons are shipped yearly to

northern markets. No system of crop rotation or of general improvement is practiced broadly and no fertilizers are ever used in maturing crops. The productiveness of the strong alluvial soils and the black prairie clays has been little affected by cropping, and good yields are continuously obtained, but the lighter sandy areas under such a system are soon reduced to a low-producing capacity.

Farm labor is composed chiefly of Mexicans and negroes, at an average price of from \$18 to \$20 a month, and is usually abundant. Day labor is paid \$1 on an average. Cultivation of the lands is done by the owners, or by tenants on a share or cash basis which is equivalent to about \$3.50 an acre. Something over 37 per cent of the farms are operated by owners.

There is a diversity of soils sufficient to accommodate all crops adapted to climatic conditions, 23 types having been established. These vary in structure and texture from a stiff heavy black clay to a loose and incoherent white sand. In the fact of crop adaptation lies the secret of a more progressive agriculture. The value of these soils is determined largely by conditions of productiveness, ease of cultivation, drainage features, and location. They range from the untillable gravelly hills and ridges to the fertile undulating clays and loams of the prairies and the river bottoms, and carry a value of from \$4 to \$80 an acre.

The Houston black clay is the strongest and most productive of the upland soils, yielding continuously without fertilization from one-half bale to 1 bale of cotton per acre and from 30 to 60 bushels of corn. Oats and sorghum do well and are more or less extensively grown for forage. Drainage over the type is good and a careful cultivation renders it a friable soil of good tilth. It has a value of from \$30 to \$75 an acre.

The Houston gravelly clay, while not so productive as the Houston black clay, is a valuable soil, yielding about one-half bale of cotton per acre and from 25 to 35 bushels of corn. Corn shows better yields when a good rainfall is distributed throughout the growing season. Oats, sorghum, and truck for home consumption are grown successfully. The gravel content is often sufficiently high to prevent cultivation. The topography is quite rolling and drainage is excellent. The type carries a value of from \$10 to \$35 an acre.

The Houston loam is a valuable soil for general farming, being easily handled, quite productive, and adapted to a variety of crops. Cotton yields on an average one-half bale per acre, corn from 15 to 30 bushels, oats from 15 to 30 bushels, and sorghum from 2 to 3½ tons. Potatoes and vegetables are successfully grown in limited quantities. Proper fertilization would give the type a still higher productiveness. The land is rolling and drainage is good. The average value is \$25 an acre.

The Houston series of soils, constituting the "black lands" of the prairie sections, are recognized as the most valuable of the area. Cultivation is always profitable and the uncultivated areas afford excellent pasturage, supporting as they do a luxuriant growth of mesquite, prickly pear, and native grasses.

The Susquehanna fine sandy loam, the predominating type of the area, is less productive than the Houston soils, but capable of a broad diversity of crops. Cotton is grown extensively and yields about one-third of a bale per acre. Corn, oats, and sorghum give fair to good yields, while potatoes, melons, peanuts, fruits, and vegetables do well. Tobacco is not one of the crops at present, but could no doubt be profitably grown in certain areas. The surface is rolling and drainage naturally good. Stable and green manures are essential for maintained productiveness, as the virgin fertility of the soil is soon exhausted. Uncultivated areas show a timber growth of hardwood. The land sells at from \$5 to \$20 an acre, according to local conditions.

The Lufkin sandy loam is subject to the same conditions as the Susquehanna fine sandy loam and has practically the same agricultural value.

The Orangeburg fine sandy loam is also a light soil adapted to a variety of crops. General farming can be practiced with fair to good results, but cowpeas, melons, fruits, peanuts, sweet potatoes, and probably tobacco are more adaptable crops. Peaches and all small fruits grown do well. The Orangeburg fine sand is a still lighter soil, less suited to cotton and grain, but well adapted to fruits, truck, and tobacco. The culture of tobacco has not been promoted, but experiments with this crop should be undertaken. These soils are of equal value, ranging from \$5 to \$25 an acre.

The Norfolk fine sand, occurring generally as sandy hills and ridges, is little suited for present agricultural pursuits, and almost its entire extent is covered by a growth of scrubby post oak and black jack, with some pine. Small areas are devoted to watermelons, and no doubt much of it might be profitably cultivated in melons, fruits, grapes, and vegetables, the addition of much organic matter being necessary.

The Lufkin fine sandy loam is probably less productive than any of the loamy soils, owing in part to the unyielding nature of the underlying impervious clays. The topography is level, and drainage, while generally good, is less active. The soil yields on an average one-third bale of cotton per acre and from 12 to 25 bushels of corn. Peanuts, melons, sweet potatoes, and vegetables do well. Much of the type is in its virgin state, supporting a timber growth of hardwood.

The Lufkin fine sand is the lightest soil of the Lufkin series and is adapted to light crops.

The Lufkin gravelly loam occurs on the higher ridges and is of little agricultural value, except where the gravel content is sufficiently low to admit of cultivation.

The Wilson loam is a productive soil and rather easily cultivated, cotton producing one-half to three-fourths bale per acre and corn from 20 to 40 bushels. This soil would no doubt produce good yields of all crops adapted to the climatic conditions. Uncultivated areas afford a good pasturage of mesquite and native grasses. The average value is about \$30 an acre.

The Susquehanna gravel occurs as a series of hills or ridges skirting the Colorado River Valley. The roughness of the topography and the high gravel content of the soil unfits it for agricultural purposes. Its chief value is the timber growth of hardwood and pine.

The Bastrop clay is the heaviest and strongest of the alluvial soils. Cultivation requires much care, and some of the type is subject to overflow. It is a productive soil, yielding on an average from one-half to three-fourths of a bale of cotton per acre and from 25 to 50 bushels of corn. It seems especially adapted to corn, 60 to 75 bushels being frequently produced. It has a value of from \$20 to \$40 an acre.

The Bastrop fine sandy loam is probably the most valuable of the alluvial types, as it is heavy enough for general farming and yet has a structure adapting it to a diversity of crops. The topography is undulating and the drainage good. Improvements in productiveness are easily maintained and yields are always good. Cotton produces from one-half bale to 1 bale per acre, corn from 35 to 60 bushels, and sorghum from 2½ to 4 tons. Melons, potatoes, peanuts, and vegetables do exceptionally well. Alfalfa is grown in limited areas on the heavier phases. The soil has a value of from \$35 to \$70 an acre.

The Bastrop silt loam, an alluvial soil, is devoted to the cultivation of cotton and corn, with yields varying from one-half to 1 bale of cotton and from 30 to 50 bushels of corn per acre. Alfalfa is successfully grown on small areas. Melons and potatoes do well. Some of the type is overflow land and the whole is very productive. It sells for about \$40 an acre.

The Bastrop sandy loam is the lightest of the river-bottom soils and is especially adapted to melons and truck, though cotton and corn are extensively grown. Cotton yields from one-half to three-fourths bale per acre and corn from 25 to 35 bushels, the latter crop doing better on the lower lying types. Fertilization with stable and green manures is demanded on this soil. It occupies the high swells and last terraces of the alluvial area and drainage is good. It has

a value of from \$25 to \$75 an acre, according to location and local conditions.

Irrigation covering the extent of these alluvial soils along the Colorado River is possible, and if put in operation would result in increased yields of all crops and at the same time increase the value of diversification.

Several other types of minor importance were established in the area, resulting from modifying agencies in local areas of the more extensive soils. In the development of the county these will all ultimately be found of value in the production of special crops.

SOIL SURVEY OF THE BROWNSVILLE AREA, TEXAS.

By A. W. MANGUM and ORA LEE, Jr.

DESCRIPTION OF THE AREA.

The area surveyed is located in the extreme southern part of the State of Texas. It comprises 121,024 acres, or about 189 square miles, of the southeastern part of Cameron County and lies wholly within the broad and comparatively level delta which occurs near the mouth of the Rio Grande. The area owes its irregular shape to the winding course of the Rio Grande, which flows along the southern boundary until it reaches the extreme southern point of Cameron County,

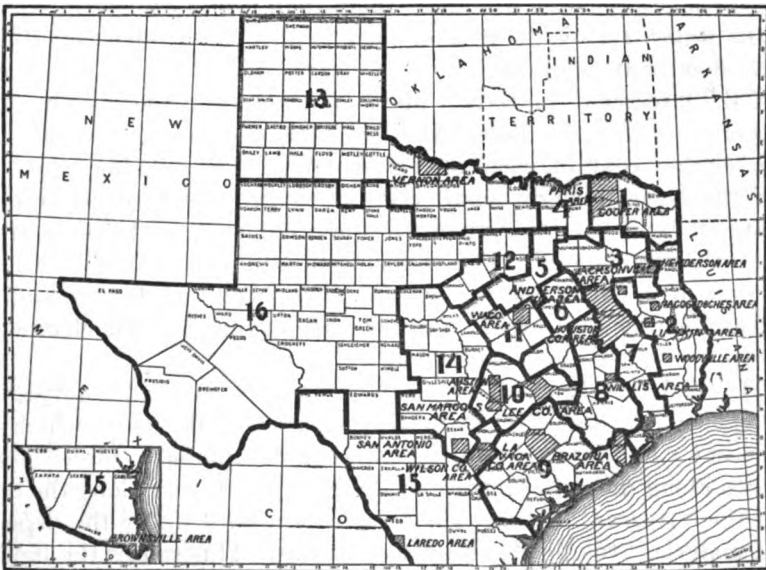


FIG. 22.—Sketch map showing location of the Brownsville area, Texas.

then bending abruptly toward the north and continuing in a general northerly direction for about 6 miles before again bending eastward toward the Gulf of Mexico.

The area is bounded on the north by that portion of Cameron County which lies north of an arbitrary line extending east and west through a point $3\frac{1}{2}$ miles north of Olmito; on the east by the Rio Grande and by a north and south line extending from the northern boundary

line to a point on the Rio Grande about 9 miles east of Brownsville; on the south by the Rio Grande, which forms the boundary between the United States and Mexico, and on the west by the Rio Grande and a line running north and south through a point $9\frac{1}{2}$ miles west of Olmito. The area is 21 miles long east and west and varies in width from 3 miles along the western to 16 miles along the eastern boundary.

The area as a whole has the general appearance of a broad, level plain, but it is traversed by numerous narrow, winding sloughs or "resacas," and small lakes or ponds also occur at frequent intervals. These sloughs represent former channels of the Rio Grande and were probably occupied by the river during the period when this section of the valley was being built up as a delta. They are often 15 to 30 feet deep and from 75 to 150 yards wide and are very crooked and winding. When the Rio Grande overflows, or at times of heavy rainfall, they become filled with water and usually contain water during the greater part of the year. The ponds and small lakes, some of which are more than a mile in length, also contain water during the greater part of the year. They are filled by the flood waters during times of heavy rainfall or by the overflow of the "resacas" or river. Many of the larger lakes, such as Lake Lomalta and Lake Tule, show but little decrease in the amount of water they contain, even during very dry seasons. Along the courses of the larger sloughs small crescent-shaped ponds which represent former bends in the courses of these old stream channels are frequently encountered. The water eventually cut through the narrow strips of land which divided the two bends of the stream, thus straightening the present channel and leaving the old channel as a deep crescent-shaped depression.

In the larger bends of the Rio Grande there is usually a distinct escarpment, several feet in height, separating the land which is at present subject to overflow from that occupying a higher terrace. Both along the upper terrace of the Rio Grande and along the courses of the "resacas" natural levees have been built up by the deposition of material brought down by the streams. This causes the land bordering these stream courses to be higher than that situated at a distance from them, and there is a gentle slope from the upper terrace of the river back toward the interior of the area, and the land bordering both sides of the "resacas" slopes gently toward areas lying between these old stream channels or toward areas between them and the river.

A large proportion of the eastern one-third of the area is low, flat, poorly drained land which has been covered very recently by the salt water from the Gulf and is at present in a stage of transition from a swampy condition similar to that found in the salt marshes near the

Gulf to that of poorly drained land which is flooded only at certain seasons of the year. Extending across this section of the area are long, narrow beaches which were formed by the waves when the country was still covered by the waters of the Gulf. These beaches vary in size from low, gently sloping elevations to steep, well-defined ridges which sometimes reach a height of 30 feet or more above the level of the poorly drained "flats." These beaches are seldom more than one-eighth of a mile in width, but often extend for a distance of several miles in a more or less broken ridge.

The natural drainage of a large proportion of the area surveyed is poor. The Rio Grande is the only perennial stream within the area, but, owing to the fact that the general slope of the country is away from the river, it receives a small percentage of the drainage waters of the country bordering it. The course of this stream is exceedingly crooked and is constantly changing. In many of the larger bends the stream traverses a distance of from 2 to 3 miles and then returns to within a few hundred yards of the starting point. The narrow strips of land between the principal beds are constantly becoming narrower as the current of the stream cuts away the banks, and at each annual rise of the river its course is changed, either by the cutting off of some of the larger bends or by returning to some old abandoned channel and forming a new and more crooked course.

The "resacas" which traverse almost every part of the survey receive a large proportion of the drainage waters of the area, but the land bordering them, like that along the river, often slopes away from these old stream channels and causes the intervening depressions to be flooded frequently during times of heavy rainfall. The extensive, flat, poorly drained area in the northeastern part of the survey receives the drainage of a large proportion of the country bordering it. At times of heavy rainfall, when the "resacas" become full from the overflow of the river, the excess water is eventually drained into this low-lying area, causing a considerable proportion of it to remain in a flooded or marshy condition during the greater part of the season.

The better drained sections of the area are covered with a dense growth of mesquite, cactus, and other native vegetation, but as the lower lying areas are approached the growth is lighter, while the broad, poorly drained section mentioned above, as well as other smaller ones subject to overflow, support only a heavy growth of coarse marsh grass, locally known as "sacahuiste" grass.

Prior to the annexation of Texas to the Union the section in which the area surveyed is located was claimed by Mexico and was inhabited exclusively by Mexicans. Americans began to settle the area in about 1856, the majority of them coming from the older settlements of Texas; but the population increased very slowly until about 1861,

when the civil war caused the towns along the Mexican border to become important centers of trade. A very large proportion of the present population is of Mexican origin. Many of these Mexicans have crossed the border and settled in the area during recent years, but the great majority are the descendants of the early inhabitants of this section of the State. During the last five years, however, the increased transportation facilities and rapid agricultural development have attracted settlers from many of the northern States and from the northern part of Texas, so that the American population has increased very rapidly. A very large proportion of those who are at present settling in the area come from the north-central States, but many are coming also from other sections of the Union. A large percentage of the area surveyed is at present undeveloped agriculturally and is thinly settled. The most thickly settled section is found along the old military road which follows closely the course of the Rio Grande.

Brownsville, the county seat of Cameron County, is the principal town in the area. It is located on the Rio Grande, opposite the Mexican city of Matamoros, and has a population of about 8,000. Brownsville is the center of trade for the entire area, and is also of considerable importance on account of the extensive trade which is carried on with Mexico. Olmito, a town of about 150 inhabitants, located on the St. Louis, Brownsville and Mexico Railroad 9 miles north of Brownsville, is also an important local shipping point for the products of the surrounding country.

For many years the lack of transportation facilities was a great hindrance to the development of the area. A few small steamboats traversed the Rio Grande for some distance above Brownsville, and in 1873 the Rio Grande Railroad was constructed, connecting Brownsville with Point Isabel. The construction of the St. Louis, Brownsville and Mexico Railroad, however, which reached the area in 1904, has greatly increased the facilities for transporting the products to the more distant markets. The advent of this railroad, making it possible to transport early vegetables quickly to the northern markets, has been the most important factor in the rapid development of the trucking industry in the area surveyed.

There are a few well-kept public roads which traverse the more thickly settled districts, but the area as a whole is in such an undeveloped state that no extensive road system has been established.

Brownsville is the local market for all of the products of the area. The cattle are usually shipped to Fort Worth and Kansas City. A few goats are also shipped to these markets, but the majority are sold on the local market at Brownsville. The earliest vegetables are usually shipped to the larger cities of northern Texas, but a few are

shipped also to Kansas City, St. Louis, and Chicago. The later vegetables are all shipped to the larger northern markets, such as Denver, Kansas City, St. Louis, Chicago, and New York. All of the sugar cane produced in the area is used at the local sugar mill.

CLIMATE.

The climate of the area is semitropical and semiarid. The elevation of the area is only a few feet above sea level, and no part of it is more than 30 miles from the Gulf of Mexico. The prevailing southeast wind, laden with moisture and tempered by its passage across the Gulf, causes a very uniform temperature throughout the year, making the region cooler in summer and warmer in winter than a more inland district of the same latitude and altitude, but not subject to the effect of this wind.

The records of the Weather Bureau station at Fort Brown, near Brownsville, show a mean difference of only 25° F. between the coldest month (January) and the warmest month (July or August). The temperature very rarely reaches 100° F. in summer, the usual day temperature being about 90° F., while in winter it seldom gets as low as 32° F. Sometimes one or two years pass without a killing frost. The average dates of the first and last killing frosts, as recorded at Fort Brown, are December 13 and February 18, but the frosts are usually so light that only the more tender vegetation is damaged. During the winter months cold north winds, locally known as "northers," often cause the temperature to fall several degrees within a few hours. Meeting the moisture-laden breezes from the Gulf, they usually cause rain, and it is only when unaccompanied by rain that they are likely to bring frost. A "norther" generally lasts two or three days, and sometimes several follow in quick succession, though there is usually a period of several weeks between them. These "northers" are not as severe in this section of the State as they are farther north, and unless accompanied by rain they do not interfere with agricultural operations. The normal winter temperature is very favorable for farm work.

The records at Fort Brown show a normal annual rainfall of about 28 inches, distributed quite evenly through the year, with the exception of April, which is very low, and September, which is relatively high. The rainfall is sufficient to support the less exacting cultivated crops, but the area as a whole is classed as semiarid. The atmosphere, however, is very humid, as the winds from the Gulf are heavily laden with moisture.

The following table, compiled from the records of the Weather Bureau station at Fort Brown, situated in the southern part of the

area, shows the normal monthly and annual temperature and precipitation:

Normal monthly and annual temperature and precipitation.

Month.	Fort Brown.		Month.	Fort Brown.	
	Tempera- ture.	Precipi- tation.		Tempera- ture.	Precipi- tation.
	<i>°F.</i>	<i>Inches.</i>		<i>°F.</i>	<i>Inches.</i>
January.....	59	1.5	August.....	84	3.0
February.....	63	1.5	September.....	80	6.2
March.....	68	1.4	October.....	74	3.6
April.....	73	0.7	November.....	67	2.0
May.....	78	2.2	December.....	61	1.4
June.....	82	2.7	Year.....	73	28.2
July.....	84	2.0			

AGRICULTURE.

From the early settlement of the area up to within very recent time the whole of Cameron County was utilized as an immense pasture for herds of horses and cattle, which were branded by their owners and allowed their freedom the year round. The lower part of the county, in which the area surveyed is situated, is well watered by the Rio Grande and by numerous large, fresh-water ponds and "resacas," making it well adapted to stock raising, and the owners of the large ranches have always been very prosperous.

Cotton and corn have been cultivated to a limited extent since the area was first settled, and sugar cane has been successfully grown under irrigation for more than thirty years, but no extensive areas were put under irrigation and very little interest was taken in the agricultural development of the locality until about 1902, when a considerable acreage was irrigated and utilized in growing rice. Rice was grown successfully for about three years, but the large amount of water used in flooding the rice fields caused both the soil and subsoil to become thoroughly saturated, and as very little or no provision was made for the proper drainage of this land the evaporation of the water caused the alkali which was taken in solution to be brought up and deposited on the surface. The topographic position of much of this rice land made drainage very difficult, and after the water had evaporated the heavy clay soil baked and sun cracked to such an extent that thorough cultivation was almost impossible. This lack of thorough drainage, resulting in the accumulation of alkali and in the hard, baked condition of the soil, caused the acreage in rice to decrease steadily until 1906, when the crop was abandoned entirely.

Small truck gardens, which were cultivated to supply the local market, demonstrated that both the soil and climatic conditions were well adapted to the production of many varieties of early vegetables, but owing to the lack of transportation facilities no attempt was made

to grow these crops on a large scale until the St. Louis, Brownsville and Mexico Railroad reached the area in 1904. Since the building of this railroad the development of agriculture has progressed very rapidly. Extensive tracts of land have been cleared and put under irrigation, and the area is now becoming one of the principal truck-growing sections of the State.

While stock raising is still an important industry, the large pastures are rapidly being divided into smaller tracts of cultivated land.

The climatic conditions are such as to allow the plowing of the land and the planting, cultivation, and harvesting of crops during almost every month of the year, and two or more crops are often grown on the same land during a single year. The growing of early vegetables is the principal industry in the area, although a small acreage is annually planted to cotton, corn, and sugar cane. The success of the trucking industry depends on the marketing of the crops earlier than they can be grown in areas nearer the larger markets. In the Brownsville area many of these crops are planted in the early fall, and the harvesting and marketing begins in December and continues until late in May. Later in the season, when areas farther north begin to supply the larger markets, the land which was utilized in the growing of early vegetables is cultivated to cotton, corn, or to some forage crop. Sugar cane is not grown extensively at the present time, as there is only one sugar mill in the area, but owing to the high sugar content of the cane and the large yields obtained plans are being formed to establish another large mill in the vicinity of Brownsville, and the acreage devoted to this crop may be expected to increase rapidly. The average yield for many consecutive years is estimated at about 25 to 30 tons per acre, but some of the land in the area, which has recently been put under cultivation, produced an average yield of more than 50 tons per acre. Sugar cane is usually replanted every four or five years.

The principal truck crops grown at present are Irish potatoes, sweet potatoes, cabbage, celery, lettuce, onions, cauliflower, eggplant, beets, cucumbers, melons, carrots, beans, peas, tomatoes, and spinach. Cabbages are more extensively grown than any other crop, and a profitable yield is always secured. The cabbage seed is usually sown in beds early in September and the plants are set out about the first of October. The harvesting of this crop begins about the first of January, and carload shipments have been made as early as January 15. Beets, English peas, and tomatoes are grown to a limited extent for the Christmas markets. Onions are usually set out early in December and harvested during the latter part of March or early in April. The early potatoes are planted about the middle of January and are harvested during the latter part of April or early in May. The yields are not as large as they would be were the harvesting done

later, but the higher prices obtained for the early crop more than compensate for the smaller yields. No corn is grown for other than the local market, but two crops are frequently grown and matured on the same land in a single year. Corn planted as late as the latter part of July matures in the late fall and produces a very fair yield.

Sorghum cane is also grown during the summer months as a forage crop. Lettuce, celery, cauliflower, eggplant, beets, carrots, water-melons, muskmelons, and both the California pink beans and string beans are grown very successfully for local and distant markets. Cotton is grown on both the irrigated and unirrigated land, and good yields are secured, especially where irrigation is practiced. The Cameron clay and the Laredo silty clay loam seem well adapted to the production of sugar cane, while the lighter textured soils seem better adapted to the melon and vegetable crops.

No well-established system of rotation is practiced in the area. The land is under cultivation during the entire year, and as soon as one crop is harvested the fields are prepared for another. On many of the truck farms the potato, cabbage, and onion crops are usually followed by corn or sorghum cane, as these crops can be grown and matured before the planting of the early vegetables in the fall. Cow-peas do exceedingly well on all types of soil under cultivation, and where included in a system of rotation they have proved very beneficial in keeping the soil in a productive state. Though little rotation has been practiced in the growing of sugar cane, very profitable yields are still secured from fields which have been cultivated to this crop for many years. As a rule irrigation is practiced in the cultivation of all the crops, though some cotton, as before stated, as well as corn, is grown on both irrigated and unirrigated land.

The labor employed on both the farms and cattle ranches consists almost entirely of Mexicans. This class of labor is very cheap and plentiful during all seasons of the year. On some of the cattle ranches laborers are often hired by the month, but on the truck farms they are usually hired by the day, at wages ranging from 50 to 75 cents without board.

The size of the farms in the area varies from about 100 to more than 1,000 acres. When the agricultural development of the area began the owners of the large ranches preferred to sell the land in large tracts, and the low price of the unimproved land made it possible for the purchasers to buy tracts of from 800 to more than 1,000 acres. The success of the trucking industry, however, is causing a demand for smaller tracts of land, and some of the larger areas are now being divided into tracts of 20 and 40 acres. Only a small proportion of the larger holdings was put under cultivation at first, but the remainder is being cleared and improved rapidly. The average cost of clearing the land is estimated at about \$8 an acre.

Very little land is rented for agricultural purposes, as the acreage of improved land is seldom more than the owner can cultivate; but a small acreage is annually rented either for a share of the crops or for cash. Improved farming land not under irrigation has been rented for \$1 an acre, but a rental of from \$4 to \$6 an acre has been paid for highly improved land well drained and under irrigation. When the land is rented for cash, however, the owner does not furnish the water for irrigation in cases where it is obtained from the canals of the irrigation companies. The land rented for truck growing is usually farmed on shares, the landowner furnishing the seed, water, work animals, and farming machinery and receiving one-half of the crops produced. When cotton and corn land is rented on shares the owner furnishes the land only and receives one-third or one-fourth of the crop produced. The value of the unimproved farming lands varies from about \$4 to \$25 an acre, according to location, the natural drainage, and facilities for putting it under irrigation. Land highly improved and put under irrigation is often valued at \$50 or \$60 an acre.

The thorough drainage of the heavier types of soil, a more economical use of irrigation water, and thorough cultivation of the soil would greatly increase the agricultural value of a large proportion of the land at present under cultivation. The lack of proper drainage causes the accumulation of alkali in the low depressions occupied by the heavy clay soils, especially where irrigation is practiced, as these low-lying areas usually receive the seepage waters from the adjacent fields. Because of a lack of experience in the growing of crops under irrigation, there is often a tendency to use an excessive amount of water and to substitute irrigation for cultivation.

SOILS.

The several types of soil encountered in the Brownsville area are very closely related, as all are derived from the silt, clay, and fine sand which has been deposited as a delta at the mouth of the Rio Grande. They may be separated broadly into three groups—first, those which occupy the comparatively well-drained sections of the area and owe their origin to the weathering of the material laid down at an early period in the formation of the Rio Grande delta; second, those occupying that section of the area which was covered recently by the salt water of the Gulf, and, third, that which occupies the lower terrace in the larger bends of the Rio Grande and is being modified by the deposition of fine sand and silt and clay during each annual overflow of the stream. The soils of these three divisions have been classified into eight distinct types, the separation being based principally on the texture of soil and subsoil to a depth of 3 feet; but where the agricultural value of a soil is influenced to any great ex-

tent by the lack of drainage or by its topographic position or other local influences such areas have been indicated on the soil map either by means of a symbol or, if of sufficient importance, have been classed as separate types.

During the period when the area was being built up as a delta by the Rio Grande the river had several outlets or channels, and at times of overflow the coarser materials held in suspension by the waters of the river were laid down in the swifter currents near the banks of the stream, forming a low ridge or natural levee composed of silt and fine sand. A similar deposit extends along the banks of the old stream channels, and it is also frequently encountered along the upper terrace of the present channel of the river. The weathering of this material forms the lighter textured soils, which are locally known as "resaca land." The land lying between these various channels of the river is lower than that which borders it on either side and remains in a wet, flooded condition for a much longer period. These broad, level areas were flooded at times of overflow, and the slow deposition of the finer particles of silt and clay, held in suspension by the water which covered them, has given rise to the heavy black clay which occupies the lower depressions in almost every part of the survey.

The soil occupying the areas between the low ridges bordering the old stream channels and the broad shallow depressions occupied by the heavy clay soils represents an intermediate type between the heavy clay soils of the depressions and the light silty loam on the ridges. The material deposited over these intermediate areas contains a smaller quantity of clay than that which was laid down in the lower depressions, and the amount of fine sand present is much less than that found in the material deposited nearer the old stream channels. The resulting soil is in most cases a heavy clay loam, but it varies slightly in texture, containing a larger proportion of silt where it grades into the lighter silt loam on the ridges and gradually becoming heavier as it approaches the areas of stiff black clay. These three types of soil embrace a very large proportion of all the cultivated land and occupy the greater part of the western three-fourths of the area surveyed.

In the extreme northern part of the survey there are several more or less extensive areas of a heavy brown silty clay, which is closely related to the heavier type of soil mentioned above. This type, however, does not occupy low or poorly drained depressions, and as a whole it is fairly well drained. Two small areas occur where this heavy brown clay has been laid down over deposits of silt and fine sand, forming a brown clay loam, underlain by a light silty subsoil.

The soil occupying the extensive, poorly drained "flats" in the northeastern section of the survey represents the earlier stages in

the formation of the soils over a very large proportion of the survey. The large quantity of silt and clay brought down by the Rio Grande is deposited in the shallow water near its outlet, forming extensive "clay flats" which soon become covered with a heavy growth of coarse marsh grass. As the area of these salt marshes is extended out into the water the surface is gradually built up by the continual deposition of the silt and clay held in suspension by the shallow water which covers it. At times of high water these marshy areas are flooded by the river, and the large quantity of silt and clay deposited during these overflows soon builds up the surface until it is no longer covered by the salt water.

During the earlier period in the formation of this extensive marshy area, while it was still covered by the salt waters of the Gulf, the action of the waves formed the long, narrow beaches of silt and clay which extend across the poorly drained section of the area in a series of low narrow ridges. The soil occupying these old beaches is not subject to overflow and is well drained, but its location in the poorly drained area and its limited extent cause it to be of small agricultural value.

In the larger bends of the Rio Grande the bank against which the swifter current strikes is being cut away very rapidly, while on the side within the bend a low terrace is being built up by the material deposited in the slower currents. As the course of the river is gradually changed the inner bank of the bends is built out by the deposition of the coarser material which was held in suspension, and a deep deposit of sand and silt is eventually formed, which extends from the former banks or upper terrace to the present channel of the stream. A deposit of silt and clay has been laid down upon the coarser material of these sandy terraces by the water which covered them during times of overflow, with the result that in such places is found a heavy clay loam underlain by a light sandy subsoil. The soil occupying these lower terraces is still in the process of formation, as a large amount of silt and clay is deposited over these areas at each annual overflow of the river.

The following table gives the name and extent of each soil type mapped in the area surveyed:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Lomaita clay.....	36,544	30.2	Point Isabel clay.....	4,096	3.4
Laredo silty clay loam.....	33,216	27.4	Laredo clay.....	3,136	2.6
Cameron clay.....	27,072	22.4	Laredo silty clay.....	448	.4
Laredo silt loam.....	8,448	6.9	Total.....	121,024	
Rio Grande silty clay.....	8,064	6.7			

LAREDO SILT LOAM.

The Laredo silt loam to an average depth of 12 inches consists of a light-brown to gray silt loam containing a very large percentage of fine and very fine sand. The color varies slightly with the amount of organic matter present, the soil in the shallow depressions being usually darker and slightly heavier in texture than that occupying the level areas or low elevations. This soil grades into a subsoil of about the same texture, but usually lighter in color, and often containing slightly more silt and clay than the surface soil. The large amount of fine sand and silt in the soil makes it very easy to cultivate, and when plowed the surface breaks up into a loose, friable condition. The surface of the unimproved areas, however, becomes very dry, hard, and compact and often has the general appearance of a fine sandy loam.

Small areas of this type of soil occur upon the upper terraces of the Rio Grande and also along the banks and in the bends of many of the larger "resacas," or abandoned river channels. A very narrow strip of this light, silty soil usually borders the banks of the old stream channels, but in many localities it is too narrow to be indicated on a map of the scale used. No large unbroken areas occur, but small areas, varying from a few acres to about 2 square miles in extent, are encountered in almost every well-drained section of the area surveyed.

The Laredo silt loam occupies slight elevations or low ridges, but the surface is almost level and the slope toward the old stream course or toward the areas occupying a lower topographic position is very gentle. The larger areas of the type are usually traversed by abandoned stream courses or by long, narrow, crescent-shaped ponds, which contain water during a greater part of the season. The soil is naturally well drained and is free from any harmful accumulation of alkali.

The Laredo silt loam is derived through weathering from the fine sand and silt which has been deposited by the waters of the Rio Grande during times of overflow. The areas near the river were formed during the period when the Rio Grande was building up the low natural levee which borders the upper channel. The deposits of this material, however, which occur farther back from the stream, were made during the period when the abandoned stream channels, near which they occur, were occupied by the waters of the river. This soil is covered by a very heavy growth of almost every variety of native vegetation, and especially with mesquite and cactus, which usually reach a larger growth than on any other soil in the area.

A limited acreage of the Laredo silt loam is under cultivation, but the light, silty texture of both soil and subsoil, its level topography,

and good natural drainage make it one of the most valuable soils in the area for the growing of early vegetables. It seems well adapted to cabbage, sweet potatoes, and melons, and when well cultivated it also produces very profitable yields of all crops grown in the area. Cotton and corn have been grown to a limited extent on unirrigated areas, but as the soil is easily affected by drought profitable yields are very uncertain on unirrigated land. The average yield of cabbage during the last few years is estimated by those cultivating this soil to be about 15,000 pounds per acre, but some of the well-cultivated areas produced larger yields. Onions produce an average yield of 18,000 pounds per acre, and a yield of more than 20,000 pounds is not uncommon where the best cultural practices are followed. The early crop of Irish potatoes usually yields about 60 bushels per acre, but larger yields are obtained from the crop harvested later in the season. Sweet potatoes are also grown to a limited extent and good yields are secured. There is a small acreage cultivated to peas, beets, tomatoes, lettuce, and other vegetables grown for the early market, and when well cultivated profitable returns are assured.

The unimproved land of this type of soil is valued at from \$12 to \$30 an acre, according to location in the area; but when it is cleared and under cultivation and irrigation it brings from \$40 to \$60 an acre.

The average results of mechanical analyses of this type of soil are shown in the following table:

Mechanical analyses of Laredo silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16145, 16952, 16954.	Soil.....	0.1	0.4	0.1	2.3	14.4	67.8	11.4
16146, 16953, 16955.	Subsoil....	.0	.3	.1	7.5	11.7	66.4	13.8

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16952, 18.8 per cent; No. 16953, 19.5 per cent; No. 16954, 15.3 per cent; No. 16955, 21.6 per cent.

LAREDO SILTY CLAY LOAM.

The soil of the Laredo silty clay loam consists of a dark-brown to black heavy silty loam to silty clay loam with an average depth of about 12 inches. It contains a large quantity of silt and clay, which causes the surface to bake and sun-crack to a considerable extent. The soil is sticky and plastic when wet, and the type as a whole has many of the characteristics of a soil of heavier texture. The subsoil, from 12 to 36 inches, is a light-brown to drab silty clay loam, which becomes much lighter in color as the depth increases and usually contains a slightly higher percentage of silt and clay than the

soil. The subsoil is sticky and plastic when wet, but when dry it becomes hard and compact and is easily crushed into a fine gray powder.

The Laredo silty clay loam is easily reduced to a state of thorough cultivation. The surface breaks up into a loamy friable condition free from hard clods, and the well-cultivated areas always have a desirable tilth. This soil occurs in long narrow bodies, which extend across the area, following closely the general course of the former channels of the Rio Grande. The topography of the type is almost level, but there is usually a gentle slope toward the depressions occupied by the Cameron clay. Although the Laredo silty clay loam usually lies along each side of the old stream channels which traverse the area, they receive the drainage water from a very small proportion of the type, for the land bordering the channels has been built above that situated at a greater distance from these channels, and thus the drainage is away from the streams into the depressions. This aids in keeping the latter in a wet or flooded condition most of the time. In the areas embraced by this type of soil occur a few small, shallow depressions, where water collects at times of heavy rains, but as a whole the type is well drained.

The material from which this soil has been derived was deposited in the slower currents at times of overflow of the Rio Grande, during the time when the river occupied the abandoned channels near which the soil occurs. The areas occupied by this type of soil did not remain in a flooded condition during long periods and there was not that slow deposition of the finer materials in still or stagnant water, such as took place in the depressions. During times of overflow, however, a larger amount of material was laid down nearer the stream and the silt, clay, and fine sand composing this soil were deposited in the quieter currents at a distance from the main channel. The texture of the soil varies slightly, the areas nearer the old stream channels containing the larger amount of silt and fine sand, while the heavier phase occurs along the boundary with the Cameron clay. Small accumulations of alkali sometimes occur in the shallow depressions or in small level areas, where the natural drainage is not sufficient to prevent the accumulation of salts on the surface. These small areas, however, have frequently been freed from any harmful accumulations of alkali by the construction of open drainage ditches.

The Laredo silty clay loam supports a heavy growth of mesquite, cactus, and other native vegetation, and the average cost of clearing the land for agricultural purposes is estimated at about \$8 to \$10 an acre. The Laredo silty clay loam is one of the most productive soils in the area and is well adapted to the growing of early vegetables. It also produces profitable yields of the staple crops, such as corn,

cotton, and sugar cane. Every variety of early vegetable grown in the area is successfully cultivated on this type of soil. Fair yields of both cotton and corn are often secured during a favorable season without irrigation. During the present season a limited acreage was planted to celery and a profitable yield was secured. Lettuce, melons, cauliflower, beets, peas, cabbage, onions, eggplant, cucumbers, tomatoes, carrots, and both sweet and Irish potatoes are all profitably grown on the irrigated area. Only a small proportion of the total acreage of this soil has as yet been cleared and put under irrigation. Many of the crops grown have been cultivated only on a very small scale, more or less as an experiment, but when well cultivated and irrigated very profitable yields have always been secured. Cabbage is the principal crop grown on this soil at the present time and gives an average yield of about 15,000 pounds per acre, though yields of 18,000 to 20,000 pounds per acre have been secured on well-cultivated land. The average yield of onions on this soil for the past three years is estimated at about 18,000 pounds per acre. The Irish potato crop harvested early in May usually produces an average yield of 60 to 70 bushels per acre, but larger yields are secured from the crop harvested later in the season. Sugar cane does well on this soil, giving an average yield of about 25 to 30 tons per acre during the four years between the time the field is planted to this crop and the time it is replanted. A yield of more than 40 tons per acre, however, has been secured on land recently put under cultivation.

The agricultural development of the Laredo silty clay loam is progressing very rapidly, as its topographic position causes it to be well drained and easily irrigated, and its texture makes it well adapted to the growing of early truck. The unimproved land is valued at from \$20 to \$35 an acre, according to its location in the area; but land which has been cleared and supplied with water is in many cases valued at more than \$50 an acre.

The following table gives the average results of mechanical analyses of samples of the Laredo silty clay loam:

Mechanical analyses of Laredo silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16143, 16948, 16950.	Soil-----	0.0	0.5	0.5	4.2	9.2	62.5	22.9
16144, 16949, 16951.	Subsoil----	Trace.	.2	.1	2.2	6.9	65.5	25.4

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16948, 7.7 per cent; No. 16949, 20.8 per cent; No. 16950, 17.4 per cent; No. 16951, 23.7 per cent.

CAMERON CLAY.

The surface soil of the Cameron clay consists of a heavy dark-brown to black clay which has an average depth of 12 to 15 inches. When wet, the soil is very sticky and tenacious, and on drying the surface bakes and sun cracks to such an extent that thorough cultivation is almost impossible. The subsoil—12 to 36 inches—is a heavy clay which is slightly lighter in color than the surface soil, but contains a higher percentage of silt and clay. Small lime concretions are frequently encountered in the deeper subsoil.

The surface of the better drained areas breaks up into a friable, loamy condition. The poorly drained areas are very difficult to cultivate, as they remain in a wet condition for long periods and when dry the surface is so hard and baked that the cultivation of the soil is almost impossible. This soil occurs in areas of greater or less extent in almost every locality embraced by the survey. It occupies the broad, shallow basins which occur between the abandoned river channels, and as a whole it is very poorly drained. The lower portions of these broad, shallow depressions remain in a wet and flooded condition during the greater part of the year, as they receive the drainage water from the lands bordering them. The areas are in general lower than the lands bordering the old stream channels, and thorough drainage of the lower depressions would be difficult and expensive.

The origin of this heavy clay soil can be traced to the sorting power of flowing water, the type having been built up of the finest particles carried by the Rio Grande—particles of so slight specific gravity as to remain in suspension until carried into depressions where there was practically no current after the subsidence of the floods.

The topographic position of the areas occupied by the Cameron clay, which causes them to receive the seepage water from the bordering lands, together with the lack of proper drainage, has resulted in the accumulation of alkali in almost all of the lower depressions. When the heavy clay is flooded and no provision is made for the proper drainage of the soil, as was the case in the growing of rice, a large amount of alkali is accumulated near the surface, but when the soil is well drained alkali does not occur in sufficient amounts to be harmful to crops. Several small areas where alkali had accumulated to an extent to be harmful to crops have been reclaimed recently by the thorough drainage of the land. The better drained areas along the upper slopes of the basins support a heavy growth of mesquite, cactus, and other native vegetation, but as the lower depressions are approached the growth generally becomes lighter, and the lowest portions support only a heavy growth of coarse marsh grass. Since the growing of rice was abandoned in the area, the acreage of Cameron clay under cultivation has decreased,

but where the soil is comparatively well drained it produces profitable yields of corn, sugar cane, cotton, and of many varieties of vegetables. The better drained areas seem well adapted to sugar cane and annually produce profitable yields.

Only a small percentage of the total area of this soil is at present under cultivation, and its poorly drained condition as a whole has greatly hindered its agricultural development. None of the lower depressions have been drained and cultivated, but they are at present utilized as pasture land for stock. The average yield of sugar cane is 25 to 30 tons per acre, but much larger yields have been secured on well-drained areas recently put under cultivation. Cotton is grown on both the irrigated and unirrigated areas and gives an average yield of three-fourths to 1 bale per acre. A yield of more than 1 bale per acre has been produced on well-drained irrigated land. Corn when irrigated will produce an average yield of 50 to 60 bushels per acre, and during a favorable season 40 bushels per acre has frequently been secured on unirrigated land. When irrigation is practiced two crops of corn can be grown each year. The Cameron clay is not as well adapted to the growing of vegetables as the lighter textured soils, but when well drained and thoroughly cultivated fair yields of cabbage, potatoes, and celery have been secured. Cowpeas also do well on this soil.

The average results of mechanical analyses of this type of soil are given in the following table:

Mechanical analyses of Cameron clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
16141, 16970, 16974.	Soil-----	0.0	0.4	0.2	1.5	2.2	45.8	49.6
16142, 16971, 16975.	Subsoil----	.1	.9	.1	.5	1.1	43.3	54.7

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16970, 17.9 per cent; No. 16971, 21.8 per cent; No. 16974, 17 per cent; No. 16975, 22.1 per cent.

LAREDO CLAY.

The surface soil of the Laredo clay, to an average depth of 12 to 15 inches, consists of a heavy brown to reddish-brown clay. This soil grades into a stiff, reddish-brown clay subsoil which becomes slightly heavier in texture and lighter in color as the depth increases. The Laredo clay is stiff and tenacious when wet, but is friable and granular when in a dry and well-cultivated condition. The surface of the uncultivated areas becomes hard and baked, and large sun cracks frequently occur, some of which extend down into the deeper subsoil.

The largest area of this soil occurs a few miles north of Olmito and is crossed by the northern boundary of the survey. A few

smaller areas, varying in size from a few acres to about 2 square miles, are also found in the north-central and northwestern sections of the survey.

The surface of the areas occupied by the Laredo clay is comparatively level, but there is usually a sufficient slope toward the adjacent depressions to insure very fair natural drainage. The type as a whole occupies a fairly high topographic position and does not receive the seepage or drainage water from any of the surrounding country. Slight accumulations of alkali sometimes occur in small shallow depressions, where at times of heavy rains water collects and remains until evaporated, but the natural drainage prevents the accumulation of salts over any extensive area.

The material from which this soil is derived consists of the finer particles of silt and clay deposited by the waters of the Rio Grande at a comparatively early period in the formation of that portion of the delta embraced by this survey. These level areas were gradually built up above the level of the neighboring salt marshes by the continual deposition of silt and clay held in suspension by the water which covered them during times of overflow.

Only a very limited acreage of this soil is cultivated at the present time, the remainder being covered by a heavy growth of native vegetation. Both the cactus and mesquite attain a very large growth. The average cost of clearing the land is estimated at about \$8 to \$10 an acre.

The small area under cultivation is very productive, and when well cultivated the irrigated land produces very profitable yields of corn, cotton, rice, and of many varieties of early vegetables. The average yield of rice was about 12 sacks per acre, but the continual flooding of the land, necessary in the cultivation of this crop, caused the heavy clay soil on drying to become so baked and sun cracked that thorough cultivation was almost impossible, and hence the crop was soon abandoned. The flooding of the soil during the period it was cultivated to rice also caused the accumulation of alkali in some of the lower depressions. Thorough drainage, however, has reclaimed these limited areas from any harmful amounts of salts. The average yield of cotton when grown under irrigation is estimated at 1 bale per acre. Corn has been grown to a limited extent without irrigation, and during a favorable season it produces about 30 bushels per acre. Where no irrigation is practiced, however, a profitable yield is very uncertain. No corn has been grown on the irrigated areas of this soil up to the present time. Beans, peas, cauliflower, cabbage, tomatoes, lettuce, cowpeas, and Irish potatoes have all been successfully grown. A small amount of celery was also grown during the past season with very fair results.

The improved land of this type located near a shipping point is valued at \$40 to \$50 an acre, while the unimproved land varies from \$10 to \$25 an acre, according to the location in the area.

The results of mechanical analyses of the Laredo clay are given in the following table:

Mechanical analyses of Laredo clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16960-----	Soil -----	0.0	0.2	0.4	9.4	4.1	47.6	38.2
16961-----	Subsoil-----	.0	.3	1.1	2.2	.2	84.6	62.1

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16960, 21 per cent; No. 16961, 21.4 per cent.

LAREDO SILTY CLAY.

The surface soil of the Laredo silty clay is a heavy brown silty clay having an average depth of about 15 inches. This grades into a stiff compact silty clay subsoil, slightly lighter in color, which gradually becomes more silty in texture as the depth increases. At an average depth of 25 to 30 inches the subsoil grades into a light-brown silty loam, which is sticky and plastic when wet, but often contains a considerable amount of very fine sand. The surface of this soil does not bake and sun crack to such an extent as to interfere with its cultivation, and when plowed it breaks up easily into a loose, loamy condition.

The Laredo silty clay occurs only in two small areas in the north-central part of the survey. The larger one occurs along the upper edge of the broad, poorly drained "flats" occupied by the Lomalta clay, while the smaller is located between this poorly drained area and one of the larger "resacas." Though the topography is almost level, there is a gentle slope toward the adjacent lowlands, which causes the type as a whole to have fair natural drainage. The soil is derived from the silt and clay which were deposited at a time when these broad, level areas were frequently flooded by the overflow of the river. The finer particles of silt and clay forming the soil were laid down over the coarser silty material of the lower subsoil, which probably had been deposited along the low beach of the old salt marshes or had been laid down near the old stream channels at times of overflow.

In the larger area of the type there are small, narrow depressions where alkali has accumulated to such an extent as to be harmful to most cultivated crops. These small areas, however, are easily reclaimed by thorough drainage. A large proportion of both areas of the Laredo silty clay is cleared and under cultivation. The unim-

proved land, which borders the Lomalta clay, is not as well drained as that which is under cultivation, and small areas where alkali has accumulated on the surface occur more frequently. When well drained the irrigated land produces very profitable yields of corn, cotton, sugar cane, and several kinds of vegetables. Lettuce, cauliflower, tomatoes, beans, peas, and cabbage have all been grown for the early northern markets. The smaller area is not at present under irrigation, but during a favorable season a fair yield of cotton or corn is secured.

The average results of mechanical analyses of this type of soil are given in the following table:

Mechanical analyses of Laredo silty clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16966, 16968	Soil.....	Trace.	0.4	0.1	1.5	7.8	57.8	32.0
16967, 16969	Subsoil....	Trace.	.1	.1	.5	3.4	66.0	29.9

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16966, 7.1 per cent; No. 16967, 19.2 per cent; No. 16968, 5.7 per cent; No. 16969, 25.5 per cent.

LOMALTA CLAY.

The surface soil of the Lomalta clay, to an average depth of 12 to 15 inches, consists of a dark-drab to black clay or silty clay. It is very stiff and tenacious when wet, and bakes and sun cracks when in a dry condition. When the surface becomes dry and baked it often has a light grayish appearance, but in the depressions where organic matter has accumulated and decayed under conditions of poor drainage the color usually varies from light brown to black. This soil grades rapidly into a light-brown to reddish-brown silty clay subsoil, which becomes lighter in color as the depth increases and often contains local beds of crystalline gypsum and small lime concretions.

The Lomalta clay occurs in one extensive unbroken body, which embraces a very large proportion of the entire northeastern one-fourth of the area surveyed. The topography is almost level, but low, shallow depressions, which remain in a wet and flooded condition during the greater part of the year, and small lakes and marshes occur at frequent intervals over the entire area occupied by this type, and the soil as a whole is very poorly drained. The type was covered by the salt water of the Gulf within comparatively recent times, and the areas bordering the shallow lagoons of salt water that extend inland from the coast are still in a marshy condition and represent the earlier stages in the formation of this soil.

A considerable quantity of alkali is present in both soil and subsoil, and the facilities for drainage are so poor that the reclamation of the land for agricultural purposes would be very difficult.

None of this type of soil is under cultivation, but it supports a heavy growth of a coarse marsh grass and is utilized as pasture land for stock. No cactus, mesquite, or other varieties of native vegetation, such as grow on the better drained soils, are found in the area occupied by this type.

The results of mechanical analyses of the Lomalta clay are given in the following table:

Mechanical analyses of Lomalta clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16956.....	Soil.....	0.0	0.2	0.2	2.3	2.5	57.5	38.1
16957.....	Subsoil.....	.3	.4	.3	1.5	1.9	67.1	28.3

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16956, 15.6 per cent; No. 16957, 20.7 per cent.

POINT ISABEL CLAY.

The surface soil of the Point Isabel clay is a heavy drab to brown clay, with an average depth of 10 to 15 inches. The subsoil to a depth of 36 inches differs very little in texture from the surface soil, but is slightly lighter in color. This soil does not become baked and sun cracked like the other heavier types, which are not so thoroughly drained, but a very thin baked crust is often formed on the surface, causing it to have a light grayish appearance.

The Point Isabel clay occurs as long, narrow ridges or beaches, which extend across the large, poorly drained basin occupying the northeast one-fourth of the area. These ridges are seldom more than a few rods wide, but often have an elevation of 30 feet or more above the level of the adjacent poorly drained "flats." The summits of the larger beaches are almost level, but the slopes are steep and abrupt and the water which falls on them is rapidly carried down to the lower levels, causing the soil to be excessively drained.

The areas occupied by this soil were formed by wave action during the period when the broad, level basin now occupied by the Lomalta clay was still covered by the salt waters of the Gulf and the silt and clay brought down by the river were being deposited in the shallow water near its mouth.

This type of soil is of little or no agricultural value at the present time, as its location in the midst of the poorly drained section of the area, its topography, and the excessive drainage render it unfit for the cultivation of the crops now grown in the area. The character-

istic growth consists of the Spanish dagger and several varieties of cactus. It also supports a light growth of mesquite.

The results of mechanical analyses of the Point Isabel clay are given in the following table:

Mechanical analyses of Point Isabel clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
16958.....	Soil.....	0.0	0.3	0.2	7.0	3.6	39.5	50.0
16959.....	Subsoil.....	.1	.1	.2	6.7	1.7	45.2	46.3

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16958, 12.9 per cent; No. 16959, 11.6 per cent.

RIO GRANDE SILTY CLAY.

The soil of the Rio Grande silty clay, to an average depth of about 12 inches, is a dark-brown to black silty clay to clay. This grades into a lighter textured subsoil consisting of silt and fine sand, which rapidly becomes lighter in texture as the depth increases, until at 30 to 36 inches it is a light-gray fine to very fine sandy loam. When dry the soil becomes hard, baked, and sun-cracked. Low ridges of fine sand and silt are encountered in the larger areas of the type, but they are not of sufficient extent to be indicated on a map of the scale used.

This type of soil occupies the lower terrace in the larger bends of the Rio Grande and is subject to overflow at times of high water. The land bordering the present channel of the stream is usually higher than that farther back from the river, forming a shallow, poorly drained basin near the foot of the upper terrace. The surface of these basins is comparatively level, but small, poorly drained depressions and low, narrow ridges, which have been formed by the currents at times of overflow, occur frequently over all of the larger areas. A lighter phase of this soil occupies the low ridges and usually contains a much higher percentage of fine sand than that found on the more level areas or slight depressions, while the stiffer clay occurs in the lower depressions, which remain in a wet and flooded condition for long periods after each annual overflow.

The Rio Grande silty clay is derived from the more recent deposits of sand, silt, and clay laid down near the present channel of the river. As the river gradually cuts away its bank on one side of the bends the opposite bank is built out by the deposition of fine sand and silt, eventually forming a low, sandy terrace. The banks of this lower terrace are gradually built up by the greater deposition of material near the present channel of the stream, and the water which collects at times of overflow in the shallow sandy basins thus formed

slowly deposits the finer particles of silt and clay held in suspension, forming a heavy silty clay soil which overlies the lighter textured subsoil. This soil is still in the process of formation in all of the larger bends of the Rio Grande.

The areas embraced by this type are covered by a heavy growth of semitropical vegetation. Extensive groves of palms sometimes occur in the better drained sections of the larger areas, while the lower depressions support a heavy growth of cane, tules, and many varieties of coarse marsh grass.

None of this soil is under irrigation at the present time, as it is subject to annual overflow and often remains in a poorly drained or flooded condition for long periods of time. The better drained areas, however, are often cultivated to cotton and corn, and when these crops are not damaged by overflow they produce very fair yields. The average yield of corn is estimated at about 30 bushels per acre, but much larger yields have been obtained on well-cultivated areas during a favorable season. Cotton does fairly well, and when not damaged by overflow or by the boll weevil a yield of from three-fourths to 1 bale per acre has often been secured. During the last few years the crop has not been damaged by the boll weevil to any great extent. The value of this land varies from \$10 to \$25 an acre, according to its location in the area and drainage conditions.

The following table shows the results of mechanical analyses of the Rio Grande silty clay:

Mechanical analyses of Rio Grande silty clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16964.....	Soil.....	0.1	0.8	3.4	10.6	2.4	41.4	42.2
16965.....	Subsoil.....	.0	.2	.0	25.0	14.4	42.1	18.4

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16964, 16.2 per cent; No. 16965, 17.7 per cent.

IRRIGATION.

The water supply for irrigation purposes is obtained from the Rio Grande and from the abandoned channels of this stream, which become filled at times of overflow and act as natural reservoirs. These old stream channels often become partially dry, but deep basins occur frequently along their courses, which contain a large amount of water during every season of the year. The water of the Rio Grande holds in suspension a large quantity of silt, which is deposited in the larger irrigation canals, causing them to fill up rapidly. The water obtained from the old stream channels or "resacas," however, has a very low silt content, as this material is deposited before the water

is used for irrigation. The following analysis of water from the Rio Grande shows the quantity of mineral matter held in solution and of silt held in suspension. This sample was taken when the river was very low, and the quantity of silt is probably less than the water contains when the river is at its normal height.

Analysis of water taken from the Rio Grande about 5 miles southeast of Brownsville.

	Parts per 100,000.
Silt in suspension	28.0
Total dissolved salts.....	96.0
Sodium bicarbonate (calculated from HCO_3).....	18.5
NaCl (calculated from Cl).....	24.2

Owing to the fact that the upper terrace bordering the river is higher than the land farther back from the stream, there is a sufficient slope to permit the use of open canals in distributing the water over the area under irrigation. At the present time the larger canals are distributing water over areas situated several miles back from the river without a second lift being necessary. Water has to be pumped from the river to the level of the upper terrace, where it enters the main canal and is carried by gravity to the areas under irrigation.

The largest system of irrigation in the area surveyed is owned and operated by a Brownsville company. This system furnishes water at present for the irrigation of about 4,800 acres and has the capacity for irrigating a considerably larger acreage. Where water is obtained from the canals of this company the landowner pays for the construction of the laterals leading from the main canal to the lands to be irrigated and pays an annual rental of \$6 an acre for the use of the water on land cultivated to cotton, corn, or sugar cane and \$10 an acre for the irrigation of land utilized in the growing of truck. The cost of constructing the lateral ditches depends largely on the nature of the country traversed by them, but the average cost per mile is estimated at from \$40 to \$50.

On some of the larger farms, located along the river, where truck and sugar cane are grown extensively, the water for irrigating purposes is pumped directly from the river to the shallow ditches, which distribute it over the cultivated fields. The small pumping stations on these farms are usually equipped with a steam pump which has a capacity for irrigating from 300 to 500 acres. The average cost of putting the land under irrigation, not including cost of pumping plant, is estimated at approximately \$4 an acre, and the daily running expenses of a plant which will irrigate 20 acres of sugar cane or 10 acres of vegetables a day is estimated at about \$3.50. Small gasoline engines are used to pump water from the "resacas" for the irrigation of the small truck farms located along the old stream channels.

The total area under irrigation within the boundaries of the survey is approximately 5,750 acres. Almost the entire area of every type of soil encountered in the survey can be easily and profitably irrigated, with the exception of the narrow ridges found in the north-eastern part and the lowlands, which are subject to overflow and so poorly drained that they are at present unfit for cultivation. The extent of the area under irrigation is increasing rapidly from year to year.

The furrow system of irrigation is used in the cultivation of all the crops grown in the area. The lateral ditches are usually about 25 or 30 rods apart, and the slopes of the fields are so gentle that the shallow furrows between the rows of plants are run straight down the grade.

ALKALI.

Alkali occurs in sufficient amounts to be harmful to crops in almost every section of the area where water collects and stands for long periods of time and where the natural drainage is so poor that this water is removed only by evaporation.

The alkali owes its origin to the deposition of the salts held in solution by the salt water which was slowly evaporated during the period when this delta land was passing from the salt-marsh stage to the stage represented by the poorly drained "flats" which have only a slight elevation above sea level. In the better drained sections of the area alkali occurs only in small depressions, seldom more than a few square rods in extent, which receive the seepage water from the surrounding land and remain in a wet and flooded condition. Thorough drainage, however, soon frees the soil from these small accumulations of salt.

Alkali frequently occurs in the lower depressions of the broad, shallow basins occupied by the Cameron clay. These shallow depressions receive the drainage water from all of the surrounding land and remain in a flooded condition during the greater part of the year. As the water evaporates the alkali held in solution by the waters which thoroughly saturated the soil and deeper subsoil, and also that contained in the seepage water from the surrounding land, becomes concentrated in the surface soil, often causing it to contain such a high percentage of soluble salts that it supports only a growth of coarse salt grass.

The greater quantity of alkali seems to occur in the deeper subsoil, and when these low-lying areas are flooded, either naturally or by irrigation, and no provision is made to drain them thoroughly, accumulations of alkali soon appear on the surface and the agricultural value of the land is greatly decreased. When these areas are properly drained, however, no harmful accumulations of alkali occur.

The soil most affected by alkali is that occupying the broad, poorly drained "flats" in the northeastern section of the area. This land was recently a vast salt marsh, and its natural drainage is insufficient to remove any of the salt which was accumulated during this stage in its formation.

The following analysis shows the chemical composition of the alkali which occurs in the area:

Chemical analysis of alkali in soil.

Constituent.	Sample taken 1 mile northeast of Olmito.	Constituent.	Sample taken 1 mile northeast of Olmito.
Ions:	<i>Per cent.</i>	Conventional combination:	<i>Per cent.</i>
Calcium (Ca).....	12.66	Calcium sulphate (CaSO_4).....	14.09
Magnesium (Mg).....	3.04	Calcium chloride (CaCl).....	23.53
Sodium (Na).....	19.03	Magnesium chloride (MgCl_2).....	11.92
Potassium (K).....	.94	Potassium chloride (KCl).....	1.80
Sulphuric acid (SO_4).....	9.94	Sodium bicarbonate (NaHCO_3).....	.97
Chlorine (Cl).....	53.68	Sodium chloride (NaCl).....	47.65
Bicarbonic acid (HCO_3).....	.71	Per cent soluble.....	3.39
Carbonic acid (CO_2).....			

SUMMARY.

The Brownsville survey comprises an area of 189 square miles along the Rio Grande, in southern Cameron County, the southernmost point of Texas. The topography of the area is almost level, and drainage as a whole is naturally poor.

A large proportion of the present population is of Mexican origin. Though the area is yet but thinly settled, its recent agricultural development has caused a rapid increase in the population, and settlers are coming in from many of the Northern and Central States.

The St. Louis, Brownsville and Mexico Railroad furnishes adequate means for transporting the products of the area to the more distant markets.

The climate is semitropical and semiarid. The winters are so mild that vegetation is seldom seriously damaged by frosts.

Stock raising was the principal industry until the railroad reached the area in 1904. Since then the agricultural development of the irrigable lands has progressed rapidly. The growing of truck for the northern markets is now the principal industry in the area. Good yields of the staples—sugar cane, cotton, and corn—are secured.

The available farm labor consists almost exclusively of Mexicans. Laborers are plentiful during all seasons of the year, and wages are low—from 50 to 75 cents a day without board.

Farming lands are usually owned in large tracts, though a very limited acreage is at present under cultivation. The rapid development of the trucking industry is causing a demand for small farms, and as a result the larger ranches are being subdivided.

Eight types of soil were encountered, all closely related and all derived from delta materials of the Rio Grande. The area was once a poorly drained salt marsh, but has been gradually built up above the level of the salt water by the silt and clay deposited during overflows of the Rio Grande. The lighter textured soils were deposited in the swifter currents near the stream channels, while the heavier clays occur in the depressions which remained in a flooded condition for long periods of time.

The Laredo silt loam, which consists of a light-brown to gray silty loam, underlain by a light silty subsoil, is one of the most valuable trucking soils in the area. It occurs near the upper terrace of the Rio Grande and borders the larger "resacas."

The Laredo silty clay loam is the intermediate type between the light silty clay bordering the "stream" channels and the heavy clay occupying the depressions. The soil is a light-brown loam, underlain by a light-brown to gray subsoil, slightly heavier in texture. It is friable and loamy when well cultivated and is one of the most productive soils of the area.

The Cameron clay is a heavy black to dark-brown clay, occupying low, poorly drained basins. It is a productive soil when well drained, but usually contains alkali, and the surface becomes so hard and baked on drying that thorough cultivation is very difficult. The depressions occupied by this type receive the drainage waters of the lands surrounding them and are frequently flooded.

The Laredo clay is a heavy brown clay which bakes and sun cracks when dry, but breaks up into a loamy, friable condition. It is fairly well drained. The very small area of this soil at present cultivated produces very profitable yields of all crops grown in the area.

The Laredo silty clay is a heavy brown clay loam, underlain by a heavy clay loam subsoil, which gradually becomes lighter as the depth increases and grades at 25 to 30 inches into a light-brown silty loam. It is comparatively well drained, but contains a small amount of alkali in the shallow depressions. Where well drained and well cultivated it produces very profitable yields of all crops grown in the area.

The Lomalta clay is a heavy dark-brown to black silty clay, underlain by a heavy silty clay subsoil which is slightly lighter in color. It occupies a broad, flat basin which was, within comparatively recent times, an extensive salt marsh. This soil is so poorly drained and contains such a large amount of alkali that it is at present unfit for cultivation.

The Point Isabel clay, which consists of a light-brown loam to clay loam, occupies long, narrow beaches in the northeastern part of the area. These ridges represent old beach lines which were formed by the action of the water during the period when this section of the area was covered by the salt waters of the Gulf.

The Rio Grande silty clay is a heavy silty clay overlying a fine sandy to silty subsoil. It occupies the lower terraces which occur in the larger bends of the river, and represents the more recent deposits of the Rio Grande. It is subject to annual overflow.

There are at present about 5,750 acres under irrigation in the area, and the acreage is increasing very rapidly. The water for irrigation purposes is obtained from the Rio Grande and from the abandoned channels of this stream. It is raised to the upper terrace of the river by pumps and carried by gravity, in open ditches, to the land at a distance from the stream. Irrigation is necessary on all types of soil in order to cultivate them with any certainty of securing profitable yields.

Alkali occurs in small poorly drained depressions in almost every section of the area, but where thorough drainage is possible the soil can be easily freed from any harmful accumulations of salts.

SOIL SURVEY OF THE COOPER AREA, TEXAS.

By **THOMAS D. RICE** and **H. C. SMITH.**

DESCRIPTION OF THE AREA.

The Cooper area comprises the southern part of Lamar County and the whole of Delta County, Tex. Lamar is one of the northern counties bordering on Indian Territory and is third in the tier starting from the northeastern corner of the State. The soil survey of the Paris area, completed in 1903, covers the northern part of the county, extending a short distance south of the Texas and Pacific Railway. The present survey completes the soil map of Lamar County and ex-

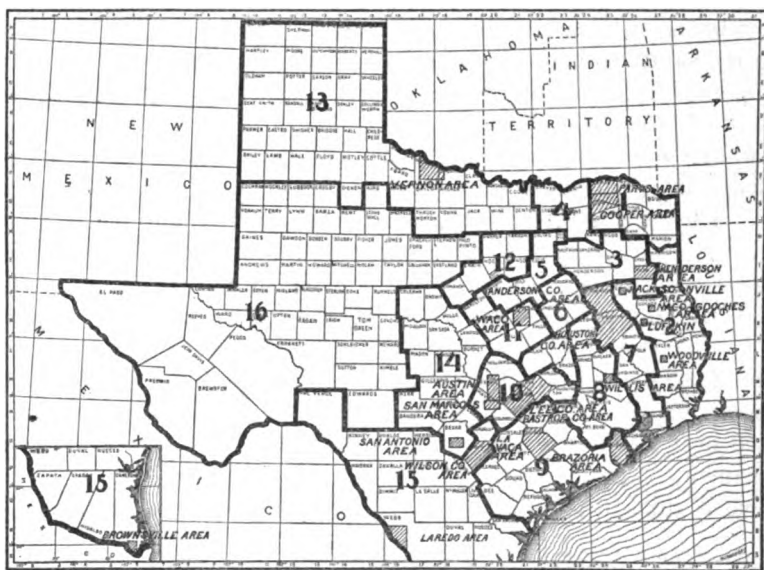


FIG. 23.—Sketch map showing location of the Cooper area, Texas.

tends directly south to include Delta County. Delta County is separated from Lamar by the north fork of Sulphur Creek and the south fork forms the southern boundary of the county. The area includes 400,256 acres or about 625 square miles.

The southern part of Lamar County is a rolling plateau, with a general slope toward the southeast. The entire drainage is effected through North Sulphur Creek by means of numerous small streams

that pursue almost parallel courses. The small streams have shallow valleys, but the stream beds have channels sharply cut into the soft underlying limestone of the prairie region. Nearly all of these streams are intermittent and become dry during short periods of drought. North Sulphur, South Sulphur, and Middle Sulphur have bands of low-lying bottom lands varying from one-half to 3 miles in width, through which the creeks meander from side to side. The smaller streams have less continuous strips of bottom land, and the lower and wider developments of their bottoms is due in many cases to deposits derived from the back waters of the larger creeks into which they empty. The lowlands are subject to overflow in every rainy season and throughout years of ordinary rainfall the bottoms are dotted with pools of standing water and traversed by old, partly filled stream channels. These lands are for the most part uncultivated, because of the overflow or the uncertainty of securing a crop. The drainage of Delta County is divided between the two forks of Sulphur Creek, the south fork receiving the greater portion. The upland portion of the area may be described as a rolling prairie with heavy black soils passing toward the streams into more hilly country with red sandy soils having a good growth of timber. This character of topography extends to the edge of the alluvial land with its dense growth of heavy timber.

Lamar County is one of the oldest counties of Texas, having been settled during the first colonization of the State between 1820 and 1845. The early settlers were a hardy class well able to withstand the hardships and dangers of the new region. They were largely from Tennessee, Kentucky, the Carolinas, and Virginia. The timbered portion of the country was first settled because of the plentiful supply of wood and water and also because the settlers were ignorant of the value of the black prairies, which at that time presented an uninviting prospect, except for grazing. The prairie region was very sparsely settled even up to the time of the outbreak of the civil war. Later experiments demonstrated the value of the black soils, and to-day the prairie is thickly settled and has an exceedingly prosperous appearance.

Paris, the county seat of Lamar County, is situated only a few miles north of the area surveyed, and near the center of the county. It is advantageously located on a main line of railroad and is the terminal point of three other systems. Its shipping facilities make it the center of an extensive wholesale trade, and it is the chief retail market for the Cooper area. The principal towns in that portion of Lamar County included in the survey are Roxton, Deport, Howland, Biardstown, Ambia, Minter, Milton, and Jennings. These towns have cotton gins and retail stores and furnish local markets for the produce of the area. Cooper, the county seat of Delta

County, is the largest town in the area. The other principal towns in Delta County are Ben Franklin, Pecan Gap, Enloe, Charleston, and Klondike.

The western side of the area is well provided with railroads, but the southeastern portion of Lamar County is without adequate railroad facilities. Lines are now under consideration, and it is hardly probable that the large timber areas of the Sulphur Creek and the town of Deport will be very long without a railroad.

Nearly all the products of the area except the principal crop, cotton, find a good local market, though a portion of nearly every product is exported. Alfalfa and other kinds of hay are demanded by the home markets, as well as all of the corn. Considerable shipments of poultry and eggs are made from the area. Cotton is ginned in the immediate neighborhood where it is grown and shipped from the most convenient railroad point.

CLIMATE.

The southern latitude of $33^{\circ} 25'$ gives this area a mild, equable climate, ordinarily free from extremes of heat or long-continued cold. The exceptions in winter are occasional "northers," which cause a sudden drop in temperature, in rare instances going below zero for one or two days. While uncomfortable and sometimes hazardous to stock, these cold waves do not interfere materially with farming operations, as they are of short duration. It is a general opinion that following crops are invariably improved by temperatures that freeze the soil to a depth of 3 or 4 inches. This takes place in a majority of winters. The extremes of summer temperature are not so marked. Although temperatures of 100° F. are not uncommon each summer, the humidity prevents too rapid loss of soil moisture, and thus the effects of drought are lessened. Unless a dry period comes in April or May when cotton is young, it is not apt to injure the yield, because cotton is a dry-climate crop. Usually the rainfall is in excess of that needed for cotton, the maximum crop being produced in the dry years of 1899 and 1900. A total crop failure owing to dry seasons has never occurred, although the yield may be somewhat reduced once or twice in a decade.

The average date of the last killing frost in spring and of the first in the fall, as deduced from records covering a period from 1898 to 1904, was March 26 and November 14 at Paris, and March 30 and November 14 at Sulphur Springs. The latest date of killing frost in spring for the same period was May 1, 1903, at Sulphur Springs, and the earliest in fall was November 3, 1899, at both Sulphur Springs and Paris. The figures show an average growing season of about 233 days, and as all farm crops mature in much less time, considerable latitude is allowed the farmer as to time of planting and

harvesting. Two crops of Irish potatoes can be grown annually if northern-grown seed is used in the spring.

Cotton picking begins in August and September and is continued as late as January. Farm work, with slight interruptions, may be carried on at any season of the year. Pasturage is good nine months in the year, and cattle with little feeding can graze throughout the winter. It is thus seen that cattle, hogs, and other stock can be raised at very moderate expense. On the whole, the climate is mild and healthful, free from destructive extremes, and favorable to all crops now grown, as well as many to which little or no attention is paid at present.

The following tables show the normal monthly and annual temperature and precipitation at Paris and Sulphur Springs, and also the dates of last killing frost in spring and the first in fall from 1898 to 1904, inclusive. It will be noted that the rainfall is greater from March to July, inclusive, which is the most active period of crop growth.

Normal monthly and annual temperature and precipitation.

Month.	Paris.		Sulphur Springs.		Month.	Paris.		Sulphur Springs.	
	Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.		Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.
	°F.	Inches.	°F.	Inches.		°F.	Inches.	°F.	Inches.
January.....	41.8	2.19	45.2	2.51	August.....	82.5	1.68	83.4	2.51
February.....	43.6	1.70	45.8	2.30	September...	76.3	2.54	78.4	2.98
March.....	55.4	3.21	57.0	3.64	October.....	66.3	2.24	67.8	1.22
April.....	65.1	3.20	66.0	3.15	November...	54.5	2.87	56.4	3.39
May.....	71.9	3.28	73.7	4.84	December.....			46.6	3.10
June.....	79.0	3.34	80.3	3.01	Year.....			65.3	37.04
July.....	82.8	3.12	83.1	4.44					

Dates of first and last killing frosts.

Year.	Paris.		Sulphur Springs.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1898.....	Mar. 29	Nov. 10	Mar. 27	Nov. 3
1899.....	Apr. 1	Nov. 3	Apr. 1	Nov. 3
1900.....	Apr. 12	Nov. 12	Mar. 16	Nov. 11
1901.....	Apr. 3	Nov. 16		Nov. 16
1902.....	Mar. 19	Nov. 27	Mar. 18	Nov. 27
1903.....	Mar. 24	Nov. 17	May 1	Nov. 18
1904.....	Mar. 4	Nov. 10	Mar. 28	Nov. 11
Average.....	Mar. 26	Nov. 14	Mar. 30	Nov. 14

AGRICULTURE.

The first settlers of the Cooper area, being without transportation facilities, produced the crops that supplied the immediate necessities of pioneer life. On their farms in the woodland along the streams

they produced corn, wheat, and pork, while the broad prairies furnished pasturage for their cattle. Although the land was at first held in large tracts, cattle raising was carried on only in connection with farming and not on so large a scale as in other parts of the State. The tough sod of the virgin prairie furnished a supply of good native hay, but the quantity of this hay produced has gradually decreased as the prairie has been brought under cultivation and the grass sod destroyed. Many of the early settlers came to Texas in search of good cotton land, and as soon as practicable they attempted to grow cotton on the alluvial lands, and as early as 1845 it had become the leading crop. Since that time cotton and corn have been the principal crops. After 1860, cultivation was extended to the prairie soils and for a time wheat was an important crop on the black waxy land, but its cultivation was finally abandoned. The principal development of agriculture in recent years has been in the steps taken toward a diversification of crops. Alfalfa has met with favor, and though its spread has been hindered by failures during the exceptionally wet years, it has established itself as a very profitable crop and it will eventually be extended over the soils adapted to its cultivation.

Cotton is the great money crop of the area and the prosperity of town and county is dependent upon the income from this product. Lamar County produces from 50,000 to 60,000 bales of cotton and Delta County from 20,000 to 25,000 in average years. This part of the State is noted for the good quality of its cotton. It seems that some peculiarity of the soil, together with the slight attention that has been given to selection, has produced a grade of long-staple upland cotton superior to that grown on similar soils in other sections. Corn of fair quality is grown throughout the area and good hay may be secured at small cost, but as neither of these products is raised in sufficient amounts to supply home needs, a considerable quantity of each is shipped into the area and sold at high prices. Hence it follows that a considerable part of the money realized from the sale of cotton goes to buy feed products that could be profitably grown on the farm. Dairying on an extensive scale has been neglected, though farmers and small dairymen supply the local markets. Dairy products, while they do not bring so high a price as in some cotton-growing communities, are sure of a ready sale at remunerative prices. Butter of good quality seldom brings less than 25 cents a pound and milk ranges in price from 25 to 35 cents a gallon. Little attention has been given to breeding cattle for dairy purposes or the beef market. Some good Jerseys may be seen, but the great majority of cows are of scrub or native stock. The quality of hogs kept by the farmers would be creditable to any community. As a rule only a few head are kept to consume the waste about the farm. The high price of feed pre-

vents the feeding of hogs on a large scale for butchering, but some are raising highly bred hogs to sell at a fancy price. Considerable attention is given to poultry by the farmers, and wagons run regularly through the country to gather up chickens, eggs, and turkeys, and these products are shipped by the carload from the larger towns.

On the lighter sandy soils peaches and small fruits may be grown. North of this area, and near Paris, trucking and fruit growing are important industries on the sandy soils, but here, with the exception of a canning factory that has been operated profitably at Cooper, these products have been grown only to supply home needs.

With regard to soil adaptation, it is generally recognized that the black prairie soils are not well adapted to orchard fruits, especially the peach, so these fruits are confined to the more sandy soils of the Lufkin series. Cotton and corn are grown on all types of soil, but the black and gray soils of the Houston series are most productive. So far, alfalfa has been profitably grown only on the black prairie land, or Houston black clay, and though it is not known why this is so, the crop has resisted all attempts to produce it successfully on other types of soil. Some measure of success has been attained in a small way with alfalfa on the Houston loam, but no stand has been secured on the soils of the Lufkin series. The adaptation of the Houston black clay to alfalfa will in time add to its value.

Until 1901 there had been a steady rise in all land values in Lamar and Delta counties, the best of the black prairie having risen in price to \$75 and \$80 an acre and other soils to figures ranging from \$25 to \$60 an acre; but the abnormally heavy rainfall of the last few years has caused a decline in the prices of all land, the decrease being greatest in the case of the black prairie land on account of its lack of drainage. The black and gray prairie lands now bring from \$40 to \$60 an acre and the more sandy soils from \$15 to \$25 an acre. Ordinary timbered lands subject to overflow are worth from \$5 to \$10 and good timber land is rated at a higher figure. As records show that no perceptible permanent change in climate takes place a return to drier or more normal conditions can be expected, and there is no reason why land should not go to a price even higher than before the decline.

According to the census of 1900, about one-fourth of the farms are operated by the owners. The remainder are farmed by tenants who pay a certain share of the crop for the use of the land. The black prairie lands are more generally cultivated under the tenant system than the poorer sandy lands, because the owners of the better land prospered so that they could join the retired farmers in the towns and also because this land offers a better opportunity for speculation to the nonresident. There are, however, very few large tracts of nonresident ownership. The tenant system here is by no means so

objectionable as in many of the cotton-growing communities. The land holdings are not usually large, and often the owner lives upon and cultivates the adjoining farm. The tenant system as a whole, however, hinders agricultural progress, as it stands in the way of the introduction of better cultural methods and the practice of crop rotation.

Farm laborers are drawn mostly from the white races during the greater part of the year, as few negroes live in the county, but during the cotton-picking seasons the farmers go into the towns and induce the negroes to go to the cotton fields. At such times it is a common sight to see the farmers hauling loads of cotton pickers to and from their work. The usual wage of a day laborer is 75 cents to \$1 a day, while \$17 with board is the common monthly wage. During the busy season or when help is scarce wages may be higher. The usual price paid cotton pickers is 75 cents for each 100 pounds of seed cotton, but sometimes the price rises to \$1. Expert pickers at these prices easily earn \$2 to \$3 a day.

The agricultural methods in use in the Cooper area do not differ materially from those practiced elsewhere in the cotton States, but conditions are now ripe for a change, and this change is already taking place, though gradually. The ruling high price of cotton is a great temptation to the farmer to specialize on this one crop. In the past this has been the natural course, and it would have been idle to suggest any other, but the question now is not altogether one of immediate returns, but the future productiveness of the soil must be looked to, and the sooner this is done the easier it will be to maintain crop yields. The soils of this section have held up well under the continuous cultivation of cotton, but a decrease in the average yields is noticeable, and this decrease may be expected to continue at an accelerated rate unless a proper crop rotation is practiced and humus is restored to the soil.

The farmers have displayed a commendable desire to improve their cultural methods, and the experience of the more daring and progressive has clearly shown the way along which advancement must be made. A diversification of crops is, first of all, demanded. Even at a seeming sacrifice the farmer must cease to grow the one crop, cotton, and by a proper rotation produce more of the necessities of life. In the second place, a leguminous crop, as cowpeas or alfalfa, should be a member of the rotation. On the black prairie, where alfalfa can be grown, it should by all means be one of the most important crops. The experience of those who have grown this crop for many years show how profitable it is as compared with cotton. One farmer near Enloe, through a series of unfavorable years, has averaged more than 3 tons of alfalfa hay to the acre, and the price obtained has ranged from \$10 to \$12 in fall to \$18 in the spring.

The gross returns from such a crop exceed those from a like acreage in cotton, and where the difference in the labor required and the acreage that one man can handle is considered the profit from alfalfa is very much greater. Besides this the benefit to the land is one of the most important considerations. Where alfalfa can not be grown, cowpeas, clover, and other nitrogen-supplying crops should be tried.

There are some difficulties to be met here as elsewhere by the successful farmer. The cotton boll weevil has appeared in this part of the State, and though this is its second season and it has not proved so destructive as was feared, it will still require care on the part of the farmer to combat it. It will be necessary to plant as early as possible and to grow as early maturing varieties as can be obtained.

A matter of utmost importance to the farmer of this section is the proper selection of seed. This is especially true in reference to corn. The corn grown in the Cooper area is not of the quality and quantity that might be obtained. The truly wonderful results that have followed the intelligent and systematic selection of seed corn in other States could no doubt be repeated here. Seed brought from a distance would hardly be successful here; the selection must be carried on under very different conditions of climate and soil. The improvement of cotton by seed selection has been carried on in all parts of the South for several years with good results, and now that an association has been formed to promote the improvement of corn it is to be hoped that the farmers of this area will give the work their hearty cooperation.

SOILS.

The upland soils of the Cooper area have been derived from rocks of Cretaceous age and owe their present condition to a long exposure to the agencies of erosion and weathering. Before the Cretaceous period the whole of the eastern part of Texas was included in the floor of a great inland sea, upon which was deposited the sediment brought down by streams and the remains of organisms living in these waters. At the close of the Cretaceous period the whole of this region was elevated above sea level and the rocks have since weathered into their present condition.

There are two formations from which the residual soils of the area have been derived. The Austin chalk, the older, extends from the northern border of the area southward below Enloe in Delta County, but the exact boundaries of this formation have never been closely defined. It consists of an impure chalk with bands of unconsolidated clays and marls. The weathering of the more calcareous, chalky portion of this rock has produced the heavy black prairie soil of the southern part of Lamar County and the northern part of Delta

County and the heavier gray and brown soils associated with it. The upper stratum, known to geologists as the Taylor formation, consists of layers of soft limestone, clays, shales, and marls, which when weathered produce soils very similar to those of the Austin chalk. No line of demarcation can be drawn between the soils of the two formations, as local variations are greater than the general differences in the character of the soils of the two formations.

The Houston black clay is formed from the more calcareous portion of the rocks of both ages, where the conditions for weathering have been favorable, and the black color of this soil is due to the decay of organic matter in the presence of the lime. The Houston loam represents gradation from the Houston black clay to the more sandy and lighter colored soils of the Lufkin series. It is probable that this type owes its origin in some places to a mixture of the other soils, but more often to the direct weathering of a less calcareous portion of rock. The Lamar loam is due partly to the character of the original rock from which it was derived and partly to the fact that erosion has kept the top soil washed off too rapidly for complete weathering into the Houston black clay. The Franklin loam, lying at the bottom of slopes of Lamar loam, is the wash from the latter type. The soils of the Lufkin series represent the weathered product of the shales and clays of the Cretaceous rocks. The Wabash clay, like the Franklin loam, is an alluvial soil. It borders all the larger streams of the area. The sediments from which it has been formed have been washed from the more calcareous soils of the upland, but principally from the Houston black clay, which it resembles in color and texture.

The following table gives the name and actual and relative extent of each of the several types of soil mapped in the area:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Houston black clay.....	166,272	41.5	Lamar loam.....	5,696	1.4
Houston loam.....	76,928	19.2	Franklin loam.....	1,280	.3
Wabash clay.....	61,248	15.3	Susquehanna fine sandy loam.....	128	.1
Lufkin fine sandy loam.....	51,520	12.9	Total.....	400,256	
Lufkin clay.....	37,184	9.3			

HOUSTON BLACK CLAY.

The soil of the Houston black clay, to a depth of 6 to 10 inches, consists of a deep black or drab clay, which has a most tenacious gummy consistency. The subsoil, to a depth of 36 inches, is usually a drab clay somewhat more plastic than the soil. Below 36 inches the subsoil becomes brown or yellow in color, and in some places where

the rock approaches the surface the entire subsoil may be of this color, passing into the chalky material from which the soil is derived.

The surface soil of the Houston black clay when drying breaks up into innumerable small blocks, which gives it a loamy character and permits of easy cultivation, but when thoroughly dried and further shrinkage takes place cracks several inches wide appear over the surface. The soil when wet assumes a sticky, gummy condition and becomes tenacious to a remarkable degree, so that when vehicles are driven over it, the mud adheres to the wheels in such masses that unless they are cleaned frequently travel is impossible.

The subsoil of the Houston black clay is somewhat impervious and where the drainage is not good the accumulation of water in the soil in seasons of heavy rainfall is injurious to crops.

The Houston black clay occupies large irregular areas covering the southwestern part of Lamar and the northwestern part of Delta County, the largest unbroken areas occurring between Cooper and Pecan Gap. The soil may be seen to the best advantage where the rocks have weathered deeply west of Enloe and north of Rattan. Except in the alluvial upland detached areas of the type occur over the whole of the southern part of Lamar and the northern part of Delta County associated with areas of Houston loam, and the one type passes so gradually into the other that in places no definite boundary can be drawn.

The surface of the Houston black clay is rolling, and while the type usually occupies the tops of broad gently rolling plateaus, no rule can be made as to its position on the slopes or hilltops, as this is dependent upon the character of the material from which it is derived, more particularly upon the amount of lime in the original rock.

The Houston black clay is a residual soil derived by weathering from two calcareous formations, the Austin chalk, which occurs in southern Lamar and as far south as Enloe in Delta County, and the Taylor formation south of that point. There are no marked differences in the character of the soils of the two kinds of rock. There are other formations, of Cretaceous age, that have produced the type in other parts of the State. The soil is calcareous and the deep black color is due, it is believed, not to an unusually large proportion of organic matter, but to changes taking place in organic matter decaying in the presence of lime.

The Houston black clay is everywhere a productive soil. It occurs in detached areas and belts throughout the Cretaceous formation of eastern Texas, and its presence is always marked by thickly populated and prosperous farming communities and growing cities. Dallas, Fort Worth, Houston, San Antonio, Waco, and Paris are situated on or near the Houston black clay or its associated types. In late

years excessive rains have so decreased crop yields on the Houston black clay that it has declined somewhat in value and the Houston loam has supplanted it in popular favor on account of its less impervious soil and its rolling topography. The Houston black clay has, however, a higher value than that at which it is now rated, and doubtless when drier years come it will assume its old place in the estimation of land owners. A most valuable feature of this soil is its adaptability to alfalfa. At present cotton and corn are the principal crops. The yield of cotton is one-half to 1 bale and of corn from 30 to 40 bushels per acre under good cultivation. The yield of oats is good. The yield of alfalfa is 2 to 4 tons per acre. Alfalfa hay sells readily at a good price, making it one of the most profitable crops of the area.

The native prairie grass made good hay, but the turf has nearly all been plowed and destroyed. Bermuda grass covers the land well and makes good pasture. The greater part of the Houston black clay was originally a treeless plain, but some small strips of heavy hardwood forests are found, usually along streams where the prairie fires have not kept down the trees. A few scattering bois d'arc trees are still to be seen scattered over the prairie, and wherever protected this species grows up thickly, as this type of soil is well suited to it.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Houston black clay:

Mechanical analyses of Houston black clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16385-----	Soil-----	0.0	0.2	0.4	1.8	3.2	57.2	38.0
16386-----	Subsoil----	.0	.8	.2	1.4	4.2	55.7	39.1

HOUSTON LOAM.

The Houston loam, locally known as "gray land," presents a rather wide range of texture, but the usual composition of the soil is a heavy, rather silty loam, dark gray or brown in color, and having an average depth of 9 inches, underlain by a drab or brown clay. The soil is lighter in color than that of the Houston black clay and contains a larger percentage of very fine sand. It lacks also the extreme tenacity of the Houston black clay, and the roads over this type are better. The subsoil is but little less heavy than that of the Houston black clay, but is usually lighter in color.

The Houston loam occurs in all parts of the area except in the river bottoms. It forms a border between the Houston black clay and the more sandy soils of the Lufkin series. It also occurs where thin

strata of limestone have weathered on the surface and the calcareous materials have become mixed with the more sandy soils beneath.

The Houston loam embraces all gradations in texture and character of material between the heavy Houston black clay and the lighter soils of the Lufkin series. It is formed in some places by a mixture of the other soils, but more often its origin is due to less calcareous material in the original rock than in the formations that produce the Houston black clay. Like the latter type, the Houston loam occupies broad rolling prairies and covers some hilly areas. The rolling topography as well as the more pervious character of the soil insures good drainage. For this reason farming has been more certain on this type of soil than on the Houston black clay, so that now it is considered the most valuable land in the area.

Cotton with good cultivation will average three-fourths bale per acre, and corn 35 to 40 bushels. Alfalfa has not been generally successful on this soil. It is possible to grow alfalfa on the greater part of it, but it seems more or less difficult to get a good stand. The Houston loam withstands drought fairly well, as the subsoil is retentive of moisture. All things considered it is a valuable soil deserving of its present high reputation.

The following table shows the average results of mechanical analyses of this type of soil:

Mechanical analyses of Houston loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
16381, 16383-----	Soil-----	0.0	0.2	0.3	2.5	8.3	66.3	22.0
16382, 16384-----	Subsoil----	.2	.2	.2	1.9	10.3	56.8	30.6

LAMAR LOAM.

The Lamar loam consists of a brown or yellow loam with an average depth of 12 inches, underlain by a calcareous clay of lighter color. The subsoil usually contains fragments of limestone, and lime concretions are often present. The soil where erosion has not been active is friable and easily tilled, but very little of it is under cultivation owing to its relatively low productiveness. It differs from the Houston loam in its lighter texture, abundance of calcareous material, and more rolling topography.

The Lamar loam occupies irregular strips along North Sulphur Creek. The greater part of the type is on the south side of the creek, only one area being found in Lamar County of sufficient size to be indicated in the map. There are, however, small spots of the type found in the Houston black clay areas, one of which occurs on the slope of the creek east of Clardy. The large area of this soil

stretches from the limit of the survey near Pecan Gap eastward along North Sulphur and across the Texas Midland Railroad, attaining a width of nearly 2 miles in places.

The greater part of the area is much eroded. It is cut by gullies and stream channels leading toward the creek. On account of the rough surface and its tendency to wash and gully very little of it is farmed. The land is used for pasture and has a straggling timber growth of oak and other hardwood trees.

The Lamar loam is derived from material of the same age as the Austin chalk, though it appears to be a very calcareous marl. Large shells characterize the material where the type is found and gravel deposits occur near the surface. The type owes its characteristics to the material from which it is derived and probably to the rapid erosion which has removed the surface before thorough decomposition into the black clay could take place.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Lamar loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16389-----	Soil-----	0.0	0.2	0.1	0.4	31.9	50.0	16.7
16390-----	Subsoil----	.1	.4	.2	.9	37.6	45.1	15.9

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16390, 7.36 per cent.

FRANKLIN LOAM.

The Franklin loam is a brown fine sandy loam with an average depth of 10 inches, underlain by a lighter colored brown sandy loam. The subsoil varies in texture and may be either lighter or heavier than the soil. It has the brown color that characterizes the Lamar loam.

The type occupies a strip, several miles long and from one-fourth to 1 mile wide, along the bottom lands of the North Sulphur Creek and on each side of the town of Ben Franklin. It occurs at the foot of the slopes covered by the Lamar loam and on the border of the Wabash clay area which lies between the Franklin loam and the creek. This soil is plainly an alluvial type formed by wash from the hills covered by Lamar loam. It occupies a nearly level topography, but lies higher above the stream than the Wabash clay and is but seldom subject to overflow.

Although it has a favorable location and can easily be tilled, the Franklin loam is not highly esteemed for farming, and much of it

is not cultivated. The average yields are low compared with the rich Wabash clay. Cotton yields one-half bale per acre and corn 25 to 30 bushels. It would seem that with proper treatment this should be made a valuable type of farm land. Drainage is poor on the lower terraces and during the wet season the excess of water in the soil has doubtless helped to reduce the yields. The land should be thoroughly drained. Cowpeas or other suitable leguminous crops would doubtless be beneficial.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Franklin loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16377-----	Soil-----	0.2	0.3	0.2	1.2	38.9	48.8	9.9
16378-----	Subsoil---	.1	.3	.3	1.6	35.4	49.7	12.5

LUFKIN CLAY.

The soil of the Lufkin clay is a silty loam, or less frequently a very fine sandy loam, having a depth of less than 6 inches. Where the sandy soil has a depth of more than 6 inches it has been called the Lufkin fine sandy loam. In the Lufkin clay areas the sandy top soil has sometimes been completely removed from small patches and the clay appears on the surface. The subsoil of the Lufkin clay is a compact, impervious, silty clay. The color of the subsoil is a drab or gray, mottled or flecked with red and yellow. The color depends upon the drainage and extent of the weathering; in flat, poorly drained localities the clay has a solid drab-gray or drab color, but where exposed, as on washed hillsides, it weathers to a uniform red. In texture the subsoil is a clay, containing much silt and very fine sand, the coarser grades of sand being absent. Both soil and subsoil run together when wet, like a quicksand, into an impervious mass. In dry weather the water does not readily come from beneath, and the crops consequently suffer from drought.

The Lufkin clay is found in nearly all parts of the area, usually occurring as irregular strips along stream courses. It is nearly always timbered and is locally known as "post-oak land" on account of the predominance of the post oak on the level, poorly drained portions. On the better drained portions hickory, several species of oak, and other hardwood trees are found.

The Lufkin clay is a residual soil derived by weathering from shales and sandy clays. Its existence along stream valleys is not easily accounted for, but it is doubtless due to the processes of weath-

ering by which the calcareous materials in the original rock were removed.

The Lufkin clay is cultivated to some extent and good farms may be seen on this type of soil in some parts of the area, particularly in the vicinity of Charleston in Delta County. The greater part of the type is given up to forest. North of Deport in Lamar County many farms have been abandoned, partly on account of the poverty of the soil and partly by reason of the general emigration of the tenant class to the western part of the State. The average yield of cotton on the Lufkin clay is low, ranging from one-fourth to one-half bale to the acre. The best farmers have been successful with corn, securing from 25 to 35 bushels per acre. The more sandy portions of the type are adapted to trucking and fruits, but nothing is done along this line on any large scale.

The average results of mechanical analyses, showing the texture of the Lufkin clay, are given in the following table:

Mechanical analyses of Lufkin clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16391, 16393-----	Soil-----	0.2	0.6	0.7	10.8	28.7	44.3	13.7
16392, 16394-----	Subsoil---	.1	.2	.5	7.2	22.5	40.5	29.1

LUFKIN FINE SANDY LOAM.

The soil of the Lufkin fine sandy loam is a gray fine sandy loam varying in depth from 6 to 30 inches. It contains the finer grades of sand and much silt, though the silt content is not so high as in the typical Lufkin clay soil. The subsoil is very similar to that of the Lufkin clay, consisting of a compact, impervious silty clay. In color it is a drab or gray, mottled with yellow or red, but weathered to a uniform red where it is exposed in washes or on hillsides.

The Lufkin fine sandy loam occurs in extensive tracts in the southeastern part of Lamar County and the southern part of Delta County. It is found in level prairies, as well as on the stream slopes. The deepest phase of the type is developed southeast of Cooper toward South Sulphur Creek. As a rule the drainage is better than that of the Lufkin clay; both the elevation of the type and the depth of the sandy soil prevent standing water on the surface. A large proportion of this soil on the high level stretches has been brought under cultivation for the reason that it is a productive soil, and as it was originally prairie it was easily prepared for farming. The productiveness as well as the treeless condition of these nearly level uplands is due, no doubt, to the amount of calcareous material that the soil contains. The lime content is greater near the bodies of the Houston loam, where the Lufkin fine sandy loam passes so gradually into

that type that the boundaries of the two can only be determined by the nature of the subsoil.

Cotton is the principal crop on the Lufkin fine sandy loam. The average yield is perhaps about one-half bale per acre, but larger yields are secured by good cultivation. Corn is grown to some extent and the yields are fairly good. The soil is well adapted to fruits and vegetables, but no trucking is done except to supply the local market.

The following table shows the texture of the soil and subsoil of the Lufkin fine sandy loam:

Mechanical analyses of Lufkin fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16396.....	Soil.....	0.3	0.7	0.7	9.9	31.6	44.0	11.9
16396.....	Subsoil.....	.0	.3	.3	5.5	23.4	35.6	34.6

WABASH CLAY.

Throughout the region occupied by the Houston black clay and the soils associated with it, the wash brought down by the streams has formed alluvial lands having certain characteristics. In this area this alluvial land has been called the Wabash clay. It is a black clay loam or clay with an average depth of 12 inches, underlain by a dark-drab clay somewhat heavier and more plastic in character. In color and general appearance this type closely resembles the Houston black clay and in places the line between the two types can be determined only by the topography, but over the greater part of the area the alluvial soil contains more silt and very fine sand, the percentage of the heavier materials depending upon the manner of deposition and the distance from large areas of Houston black clay. The difference between the soil and subsoil of the Wabash clay is due to the amount of organic matter in the soil.

The Wabash clay occupies the low flood plains of North, South, and Middle Sulphur creeks and their larger tributaries. It is nearly all subject to overflow, and as floods may come at any time of the year ordinary farming on these bottoms is very uncertain. The type represents a large body of land of the very highest productivity, but at present of no value except for the timber upon it and the inferior pasturage afforded by the wooded areas that are often flooded for weeks.

These black clay bottoms follow the creeks across the whole of north Texas and comprise hundreds of thousands of acres of land that ought to be of more economic value than they are at present. In Lamar and Delta counties the strips of Wabash clay follow the streams throughout the county and attain in places a width of sev-

eral miles. The most profitable way of utilizing these lowlands presents one of the most interesting problems of the area. Many plans have been devised to levee the creeks, but as any restriction of the width of the bottom overflow will increase the depth of the water in that proportion and the height to which levees must be built, the cost of such measures would be prohibitive. It has been suggested that parallel bois d'arc hedges would collect drift and soil so as to form a water-tight barrier. This method, however, would be uncertain and the formation of such a dam would take a long time, though it should be useful where the overflow waters are shallow. At the present time it seems possible to utilize these lands safely in only two ways—for pasture and for forests. To secure good pasture the land should be cleared or openings made in the forest. The present timber growth over the greater part of the land is valuable, consisting of hickory, oak, and bois d'arc. The latter tree does especially well on the black lands along the larger streams and the foresting of these areas with it would in time prove a most profitable investment. It is easily seeded or transplanted, grows very rapidly, and the wood is highly esteemed in this region for use in the manufacture of wagons and for other purposes where a hard, tough wood is required.

The table given below shows the texture of the soil and subsoil of the Wabash clay:

Mechanical analyses of Wabash clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16879-----	Soil-----	0.1	0.1	0.2	1.1	7.8	58.4	36.9
16880-----	Subsoil----	.3	.3	.3	2.2	8.0	42.3	45.7

SUSQUEHANNA FINE SANDY LOAM.

Only one very small area of the Susquehanna fine sandy loam appears in the Cooper area and this is found in the extreme northeastern part, where it occurs as a point running down from the north. The soil of the Susquehanna fine sandy loam consists of a red sandy clay loam having an average depth of 8 inches. The subsoil is a red clay mottled and streaked with gray. Over much of the surface of this type there is a thin layer of very fine sand ranging from 1 to 3 inches in thickness, and sand mounds from 1 to 2 feet high and 20 to 30 feet across are common.

The type is well drained, as it occurs in a region cut by many small streams. Very little of the type is cultivated in the Cooper area. Cotton yields about one-third bale to the acre and corn 15 to 20 bushels.

The following table shows the results of the mechanical analyses of a sample of the soil and subsoil of this type:

Mechanical analyses of Susquehanna fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
10800-----	Soil.....	0.7	0.9	0.9	17.8	20.1	28.9	25.9
16400-----	Subsoil....	.8	.5	.4	19.9	19.6	20.8	47.5

SUMMARY.

The Cooper area (400,256 acres, or 625.4 square miles) comprises the southern part of Lamar County, which has the north fork of Sulphur Creek for its southern boundary, and all of Delta County, which is triangular in shape, lying directly south of Lamar and between the north and south forks of Sulphur Creek.

The area is a high, rolling plateau broken by the valleys of North Sulphur and South Sulphur creeks and their small tributaries. All the larger streams have low flood plains varying from one-fourth to 3 miles in width and subject to overflow.

This part of Texas was settled early and the people are of American stock. The prairie portion of the area is thickly settled and many flourishing towns have sprung up. The area approaches within a few miles of Paris, a railroad center and the principal city in this part of Texas. Two railroads pass through the western part of the area, but the eastern side lacks railroad facilities. Cotton is the principal export crop and facilities are ample for ginning and marketing.

The climate of the area is mild during the greater part of the year, the only disagreeable feature being the sudden cold waves or "northers" in the winter months and occasional wind storms. A long growing season occurs between the last killing frost in the spring and the first killing frost in the fall, the average dates being March 26 and November 14, respectively. Farm work may be carried on at all seasons. Peaches and other fruits are almost sure crops. The rainfall is abundant, averaging more than 32 inches, and damage from summer droughts is rare.

Only about one-third of the farms of the area are operated by the owners. The large tenant class is mostly white. Cotton and corn are the principal crops, but the success of some farmers with alfalfa will no doubt make it a very important crop on the black prairie soil within a few years. But little fruit is grown and very little milk and butter are produced for sale. The grades of cattle are poor, but hogs are of good breeds. Poultry and eggs are shipped in some quantity. The farm labor is mostly white and wages are good. Land ranges in

value from \$10 to \$75 an acre for the black prairie to \$10 to \$30 for the sandy soils and river bottom.

The upland soils of the area have weathered from Cretaceous rocks which underlie the entire area. The more calcareous portions of the two principal formations, the Austin chalk and the Taylor formation, have produced dark-colored soils of the prairie, classed with the Houston series, while the shales and sandy clays of the same formations have produced the more sandy soils. There are also two alluvial types.

The Houston black clay is a deep black or drab black gummy, sticky clay, underlain at lower depths by the partly altered rock. A large part of the upland is prairie formed of this and related soils. When dry the soil is loamy and easily worked, but when wet it becomes so tenacious that it is almost impossible to drive over the roads. The type covers broad rolling prairies. The drainage is usually adequate, but in recent wet years crops have suffered from too much water in the soil. It is one of the most desirable soils of the area. Cotton yields as high as 1 bale per acre and corn 30 to 40 bushels. Alfalfa is grown with success and is the most profitable crop of the area.

The Houston loam, locally known as "gray land," is a dark-gray or brown heavy loam 9 inches deep, underlain by a drab or brown clay subsoil. Its topography is similar to that of the Houston black clay and its origin is the same. It occurs between areas of the latter type and the more sandy soils. In wet years the soil is more productive than the Houston black clay. Cotton yields three-fourths bale per acre and corn 30 to 40 bushels.

The Lamar loam is a brown or yellow loam 12 inches deep, underlain by calcareous clay of lighter color which usually contains limestone fragments and lime concretions. The type occurs on the slopes of North Sulphur creek and is hilly and broken. It is not very productive and very little is cultivated. It owes its origin to the character of the original rock and the rapid erosion of the surface.

The Franklin loam lies at the foot of the slopes covered by the Lamar loam, and is formed from the washed material. It is a brown sandy loam 10 inches deep, underlain by lighter colored sandy loam of varying texture. Although well situated it has a low agricultural value. Corn and cotton are the chief crops.

The soil of the Lufkin clay is a silty loam with fine sand to a depth of less than 6 inches. The subsoil is a characteristic mottled, compact, impervious silty clay. Both soil and subsoil run together when wet and form an impervious mass. It occurs along stream slopes and is derived from the shales and silty clays of the Cretaceous rocks. Some good farms are found on this type of soil, but average yields are low. Cotton yields less than one-half bale per acre. The greater

part of it is uncultivated, being timbered with post oak and other scrubby oaks.

The Lufkin fine sandy loam is a gray fine sandy loam 6 to 30 inches deep, underlain by a silty, compact, mottled clay subsoil similar to that of the Lufkin clay. This type occurs on the higher, more level prairies and is extensively cultivated. It is not so productive as the Houston loam which it borders in many places, but yields are good. One-third to two-thirds of a bale of cotton per acre is secured and corn yields well.

The Wabash clay is the typical black alluvial land found along streams in Houston black clay areas. It is a black clay or clay loam 12 inches deep, underlain by a dark drab clay more plastic than the soil. The land is subject to overflow and scarcely any of it is cultivated at present. It is a strong soil and makes heavy yields where it can be farmed.

The Susquehanna fine sandy loam is an unimportant type which occurs in one very small area. It is a red sandy clay loam, underlain by a red clay mottled with gray. Thin layers of sand and occasional sand mounds cover the surface. It has very little agricultural value in this area.

SOIL SURVEY OF CONWAY COUNTY, ARKANSAS.

By JAMES L. BURGESS and CHARLES W. ELY.

DESCRIPTION OF THE AREA.

Conway County is located a few miles northwest of the geographical center of the State of Arkansas, and lies between $92^{\circ} 52'$ and $92^{\circ} 30'$ west longitude and $35^{\circ} 5'$ and $35^{\circ} 27'$ north latitude. On the north it is bounded by Van Buren County, on the east by Van Buren and Faulkner counties, on the south by Perry County and the Arkansas River, and on the west by Pope and Yell counties. The county is traversed in the southern part by the Fort Smith and Little Rock division of the Missouri Pacific Railway.

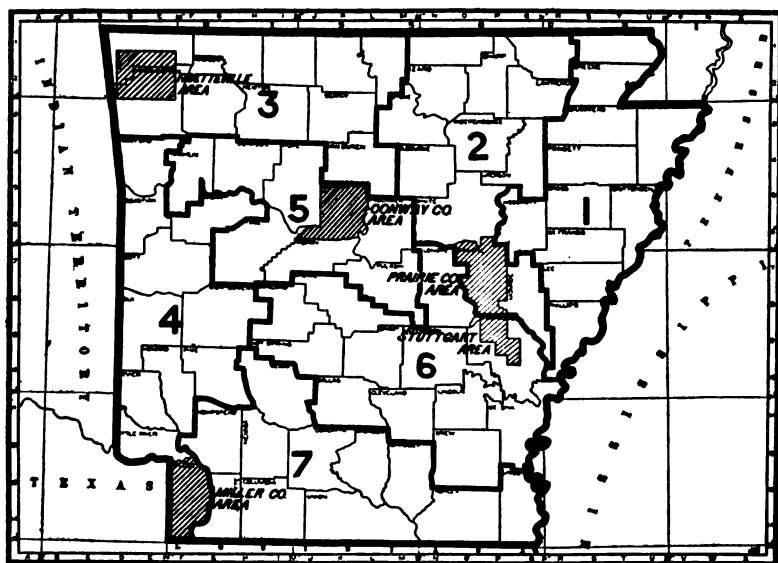


FIG. 24.—Sketch map showing location of the Conway County area, Arkansas.

There are two distinct physiographic divisions in the county. The more important from an agricultural point of view is the Arkansas River Valley. It is from 3 to 10 miles wide and is extended by the coalescing valleys of the Cadron and Point Remove creeks, which flow into the Arkansas River from the north, and by the valley of Petit Jean Creek, a tributary from the region to the south. The surface of the valley is level to gently rolling, the river having a fall

here of approximately 1 foot to the mile. Some of its larger tributaries, for instance Point Remove Creek, have an average fall of 20 feet to the mile. Most of the river bottoms are well drained and some thousands of acres are protected from annual overflow by levees.

The surface features of the uplands, or the second physiographic division, range from level to gently rolling, hilly, and mountainous. The average elevation of the county is about 500 feet above sea level, the lowest point being about 300 feet and the highest, where Petit Jean Mountain juts out into the Arkansas River Valley, about 1,000 feet. The most rugged part of the area lies north of a line running east and west across the county and some 8 or 10 miles north of Morrillton. North of this line are found many very pronounced residual hills, locally called mountains, the most important of which are Pigeon Roost, Wild Cat, Bull, Grayson, Lost, and Devils Knob mountains. The most broken part of the area lies west and northwest of Center Ridge and along Point Remove Creek, west of Cleveland. While there are thousands of acres of land among these mountains too rough for cultivation, there are on their tops mesalike plateaus that support a great many inhabitants. Here the surface features are not so broken and a great deal of good level land is found. Nearly all the area north of the river is drained by Point Remove Creek, which enters the river just south of Morrillton. All the precipitation over the county finally reaches the Arkansas River, mainly through Cadron, Point Remove, and Petit Jean creeks and their tributaries. The general slope of the area is to the south.

The physiographic divisions of the county also divide the population. The colored people are generally found as tenants on the fertile lands along the river, while most of the white people farm their own lands among the hills. Most of the people of the area are of native birth, their parents having come from the different southern States. Some years ago a colony of Germans and Swiss located here, some near Morrillton and some near St. Vincent. There is also a small colony of Italians in the neighborhood of Center Ridge. Most of the citizens of foreign blood are energetic and thrifty and make good farmers. The county contains at present something over 20,000 people. Morrillton, the chief town and county seat, claims from 2,000 to 3,000; Plumerville, the second town in importance, has from 400 to 500 people. The rest of the population is rural and composed mainly of farmers located in the hill country. There are a number of small country villages with schools, post-offices, churches, stores, etc., for the accommodation of the rural classes. The most important of these little towns are Springfield,

the old county seat, Center Ridge, Cleveland, Hattievile, and Solgohachia. The railroad being located far to the south, the farmers in the northern part of the county are compelled to haul their produce long distances to Morrillton, the nearest market. Morrillton and Plumerville are the chief points for selling and buying and from these points shipments of various kinds of produce are made to Little Rock and Memphis over the Missouri Pacific Railway. A very large exchange business is done at both Morrillton and Plumerville, since they are the nearest shipping points and trading stations for vast stretches of the mountainous country to the north and west of this area. Until recently country merchants hauled freight from Morrillton over 100 miles into the mountains.

CLIMATE.

Conway County is well within the humid belt of the Mississippi Valley, and, as the following table shows, has a precipitation of over 45 inches during the year. The temperature rarely reaches 90° F. in the summer and zero weather is uncommon in the winter. The climate is, therefore, equable. While the climate as a whole is generally mild and favorable to the production of the staple crops of the area, the range in elevation, from 300 to 1,000 feet, causes local differences in climate that are of extreme importance to fruit and truck growers. It is frequently noted that frost comes much earlier and much later in the valleys than on the "mountain" tops and slopes, and fruit growers must be careful to locate their orchards with due regard to these local differences, avoiding hollows where the cold air settles.

The following tables show the precipitation and temperature and also the dates of last killing frosts of spring and the first of fall:

Normal monthly and annual temperature and precipitation.

Month.	Conway.		Russellville.		Month.	Conway.		Russellville.	
	Tem- pera- ture.	Pre- cipita- tion.	Tem- pera- ture.	Pre- cipita- tion.		Tem- pera- ture.	Pre- cipita- tion.	Tem- pera- ture.	Pre- cipita- tion.
	<i>°F.</i>	<i>Inches.</i>	<i>°F.</i>	<i>Inches.</i>		<i>°F.</i>	<i>Inches.</i>	<i>°F.</i>	<i>Inches.</i>
January----	39.4	3.72	39.8	2.97	August-----	79.2	3.04	70.7	3.30
February----	42.3	4.13	40.9	3.01	September---	78.3	3.38	73.4	3.90
March-----	51.9	4.85	52.2	5.29	October-----	61.1	2.07	61.2	2.95
April-----	62.3	3.57	62.1	2.93	November---	49.9	4.09	49.8	3.43
May-----	69.6	4.82	69.8	4.91	December---	42.4	3.93	42.3	3.13
June-----	75.8	4.02	77.3	3.79					
July-----	80.4	3.51	81.3	4.35	Year----	60.6	45.15	60.8	43.99

Dates of first and last killing frosts.

Year.	Conway.		Russellville.		Year.	Conway.		Russellville.	
	Last in spring.	First in fall.	Last in spring.	First in fall.		Last in spring.	First in fall.	Last in spring.	First in fall.
1898.....	Apr. 7	Oct. 22	Apr. 6	Oct. 27	1902.....	Mar. 19	Nov. 26	Apr. 11	Nov. 27
1899.....	Apr. 9	Nov. 3	Apr. 9	Nov. 3	1903.....	Apr. 4	Nov. 7	May 1	Oct. 24
1900.....	Apr. 12	Nov. 9	Apr. 13	Nov. 7	1904.....	Apr. 10	Oct. 23	Apr. 10	Oct. 23
1901.....	Mar. 21	Nov. 16	Mar. 22	Nov. 13	Average	Apr. 3	Nov. 6	Apr. 10	Nov. 4

AGRICULTURE.

Prior to 1825 part of this area lay in what was then the Indian Territory, and the old Cherokee line now runs through the town of Morrillton. Well-marked indications of Indian occupation are still to be seen.

It is not known when the white man first settled in this part of the State, but in 1825 there were citizens enough to warrant the formation of a separate county. Accordingly Conway County was taken piecemeal from Van Buren, Faulkner, Pope, and Perry, and obtained its present boundaries some time in the forties.

There was no railroad in the county before 1873, and up to that time all the traffic, except that done in wagons, overland, was by way of the river, the shipping point being old Louisburg, then the largest town in the area. The overland traffic was done by means of teams to Des Arc, some 80 miles away.

In farming operations oxen were generally employed, and all farm implements and articles of clothing were made in the local shops and on the private hand looms. At that time the few slaves in the area were generally confined to the bottom lands, only a small proportion of which were under cultivation.

Cotton and corn have been the staple crops of the area from the earliest times, and until recently little diversification has been practiced.

In 1873 the railroad came, and with it a great impetus to agricultural progress. Most of the cultivable land along the river has since been cleared and put under the plow; the river traffic has been reduced to that done by the ferry boats; and where hundreds of bales of cotton were once grown thousands are now produced. Old Louisburg has been practically abandoned and all its business houses moved to Morrillton.

Excepting a very limited lumber trade, there is no business done in the area, except in the exchange of agricultural products, and where old Louisburg did a volume of business of only a few thousand dollars a year, Morrillton alone now handles annually cotton, cattle, hides, miscellaneous country produce, cotton oil-mill products, general merchandise, etc., of a value of nearly \$4,500,000. Plumerville

also does a volume of business of perhaps nearly \$1,000,000 a year, to say nothing of the business transacted at the various smaller country villages throughout the area.

Most of the agricultural products exchanged at these various points are produced in the county, and the limit of production has by no means been reached.

The most valuable products are cotton and corn, although considerable money is realized from the sale of home-grown wines, apples, and truck. The one-crop system is largely practiced, but many of the more progressive farmers and land owners are beginning to grow a greater variety of crops and are producing peas, alfalfa, and fruits in addition to the staple crops.

Fruit trees are generally located in the hill country and on the tops of the mountains. In this case the recognition of adaptation appears to be one of location rather than of soils. As a rule the farmer puts his plants where conditions appear favorable, and must learn by experience that commercial success with certain crops can be attained only on certain soils and by definite methods of soil management.

The labor problem is not serious in this area, since most of the farmers operate their own farms and their work is done either by themselves or by the joint help of the family. There are a number of drifting laborers that may be hired for \$20 or \$25 a month during the summer.

Most farmers in the hill country own their farms, but the rich alluvial bottoms are generally farmed by tenants, and owned by various business men of the towns. The general size of the farms in the area is about 50 acres and the value ranges from \$5 an acre in the uplands to more than \$50 an acre in the bottoms.

There are several lines along which improvements in the agriculture of the area should be made. More attention should be given to the production of forage and feeding stuffs for consumption on the farm, to take the place of hay and grain now bought by the farmers. On all the hill lands an intelligent and systematic rotation of crops should be practiced; more cowpeas should be grown for both forage and grain, and these could be turned to good account in the production of pork, at least to the extent of supplying home needs. Most of the farmers might add materially to their income by raising a number of mules for the market. The conditions for this line of stock raising are favorable provided it is not attempted on too large a scale. There is great need that all the farmers, both in the bottoms and on the hills, should give special heed not only to maintaining the productive capacity of their farms, but to increasing it. Methods for doing this will be discussed in connection with the individual soil types,

SOILS.

The upland soils of Conway County are derived from rocks of Carboniferous age, the particular strata belonging to the Coal Measures. The surface of the area appears at one time to have been a nearly level plateau, but erosion and subterranean disturbances have carved and twisted the surface into a multiplicity of ravines, gorges, and escarpments, and dotted it with many residual mountains. A great fault, or fracture, traverses the area from west to east and presents a number of interesting features. This fault is about 10 miles wide and is made up of a number of anticlines and synclines, running in a general parallelism with the river. The strata dip both north and south, while their strike runs in an easterly direction. The most important syncline in this disturbed area contains the present bed of the Arkansas River.

The underlying strata of the area are composed of interstratified layers of sandstone and shale. The upper sandstones belong to the Millstone grit, while the shales belong to the more argillaceous materials of the Coal Measures. Some of the strata of the Millstone grit are held together by a ferruginous cement, while others are bound together by a siliceous matrix. This difference in the cementing material gives rise, in the weathered product, to two different types of soil. The shales are usually more or less arenaceous and silty, and where they are exposed, either by disturbance of the earth's crust or by the erosion of thin beds of sandstone from above, a heavier type of soil, corresponding closely to the material of the underlying rock, is developed.

All the soils of the uplands show markedly the influence of differences in the underlying rocks. These rocks are disintegrated to a depth of from a few inches to 30 or 40 feet, the greatest depth of the soil mantle occurring where the shales are exposed. With the exception of the fault discussed above, the strata lie practically horizontal over the entire area, and where the sandstone is thickest are found the residual mountains with their broad table-lands on top. Around the edges of these plateaus erosion has developed a type of soil that includes the various escarpments and rough stony areas.

The soils in the bottom lands are markedly different from those in the hills. They are derived from sediments gathered over the vast territory drained by the Arkansas River from here back through the Territories, Kansas, and Colorado to the Rocky Mountains. Flowing as it does through a vast stretch of semiarid territory, enormous amounts of unleached sediments are carried in its waters during the annual floods and intermixed with the local sediments brought down by the streams of the area. The bottom-land soils are, therefore, an admixture of arid, semiarid, and humid sedi-

ments, thus making a soil of well-balanced fertility. These soils are all of fine texture and the most productive in the area. All the soils in the area, however, both residual and alluvial, appear to lack sufficient lime for crop requirements.

There are two types of soil on the uplands that, by reason of their peculiar structural features and topographic position, are not always sufficiently well drained for the staple crops. The bottom lands are generally well drained, excepting a few local depressed areas where the surface drainage collects, and a large tract of heavy clay land of level to flat surface northwest of Morrilton, where the bottom lands along Point Remove Creek join those of the Arkansas River. Here ditching and tile drainage must be resorted to for success with the ordinary cultivated crops.

The water table in the lowlands varies in depth from a few inches to perhaps 10 feet or more, rising and falling with the rise and fall of the water in the river. The subdrainage of these lowlands is effected largely through the thick layer of sand that is found at various depths under these soils generally.

The soils of the area have been classified, according as they differed in origin, mechanical composition, depth of soil and subsoil, topographic position, and agricultural value, into nine different types. Five of these occur on the uplands and four are found along the streams. On the uplands are a silt loam, a loam, a fine sandy loam, a stony loam, and a type known as Rough stony land. The soils of the bottom lands have been differentiated into four types, viz, a fine sand, a fine sandy loam, a silt loam, and a clay.

The soils of the hill country have been correlated with the Fayetteville series of soils. The river-bottom soils belong to the Wabash, which has its typical development along the Mississippi River and its upper tributaries.

The following table gives the names and extent of the several types of soil found in this area:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Fayetteville stony loam.....	118,400	32.2	Fayetteville fine sandy loam..	17,216	4.7
Rough stony land.....	82,368	22.4	Wabash fine sandy loam.....	10,112	2.7
Fayetteville loam.....	44,332	12.1	Wabash fine sand.....	4,480	1.2
Conway silt loam.....	38,912	10.6	Total.....	367,808	-----
Wabash silt loam.....	28,928	7.8			
Wabash clay.....	23,040	6.3			

FAYETTEVILLE STONY LOAM.

The soil of the Fayetteville stony loam is composed of various grades of rock material ranging from clay to good-sized gravels and

stones. It contains a large percentage of fine gravel composed of shale and sandstone fragments. This gravelly nature extends frequently to great depths and renders the structure of the soil quite open and porous. Neither the texture nor the structure is uniform over very wide areas, but small clayey, sandy, and gravelly phases are found here and there, corresponding closely to differences in the underlying country rock. The soil is of a gray to reddish-gray color and about 14 inches deep. The depth of the soil is rather uniform. The subsoil varies in texture from fine sandy and gravelly material to clay and silt. In depth it ranges from 1 foot to 30 feet, but it is always underlain by flat rock masses. Sometimes the sandstone comes to within a few inches of the surface and renders the soil useless for general agriculture. These areas, where the country rock lies horizontal and too near the surface, may easily be detected by the nature of the vegetation. No well-developed trees grow here, and the land is generally very wet, owing to the inability of the water to sink below a certain point. Farms in the uplands should be carefully searched for these shallow soil areas, because there are tracts with attractive topographic features, but with an impenetrable layer of sandstone just beneath the surface, and with both soil and subsoil not more than 1 or 2 feet deep. The color of the subsoil changes from yellowish-gray to red and yellow, and generally contains a large percentage of gravel. This type of soil is easily cultivated, except for the resistance offered by rocks and gravel.

The Fayetteville stony loam is an upland soil and the most widely distributed type in the area. Its greatest development is found in the northeastern part of the county, but small areas are scattered here and there over all parts of the hill lands. The surface of this type is rolling to hilly. With the local exceptions noted above it is always well drained both topographically and texturally, having a generally open and porous subsoil as well as a rolling surface. It is found on both high and lower elevations; it occupies ravines as well as the table-lands on the mountain tops.

The Fayetteville stony loam is derived from the breaking down of shales and the more ferruginous members of the Millstone grit strata of the Coal Measures. There are always certain parts of these iron-cemented sandstones, and of the shales as well, that are quite resistant to weathering, owing doubtless to the character of the cementing material, and hence there are found remaining in the soil innumerable shale and sandstone fragments of dark-brown and reddish colors. In the case of the sandstone, the broken bits may range in size from that of a pea to huge boulders.

The weathering of these rocks has been effected by the action of acidulated waters on the iron cement and also by temperature

changes. The shales break down readily under the action of cold and heat, hydration, physical absorption of water, the action of plants, etc. Wherever the rocks are found on or near the surface they are systematically split into rectangular forms that to the casual observer appear like bricks of various sizes. It is characteristic of the sandstones and arenaceous shales of this area to break at right angles when weathering; thus the flat rocks in the stream beds always present a checkered appearance and rectangular blocks are plentiful all through this type of soil.

The native vegetation on the Fayetteville stony loam is post oak, black oak, and blackjack oak, with some hickory and various shrubs. This is perhaps the best apple, peach, and grape soil in the county, and, with better transportation facilities, a large and profitable fruit industry might be developed. With present market conditions about the only fruits that can be safely recommended, except where the land lies near the railroad, are apples and grapes. This is because apples will keep for a number of weeks, and grapes may be made into wine at once. Apple growing may be made quite profitable on this soil. The crops grown at present are corn, cotton, some apples, and grapes. The farmers consider this the strongest of the upland soils. When first brought under the plow it sometimes yields as high as one-half bale of cotton and 25 bushels of corn to the acre. Unless care is used to replenish the organic matter this virgin productiveness disappears after a few years of continuous cropping and in about fifteen years the farmer must clear new fields. About 15 bushels of corn and one-third of a bale of cotton per acre are fair average yields, taking good and bad years into account. If the farmers will rotate their crops, however, and take the precautions observed by the best farmers of the country, there is no reason why the fields should not be made much more productive and maintained in that condition.

Small one-horse implements are in most general use, though many of the farmers are adopting more improved machinery in the cultivation of this soil. The land should be plowed about 5 inches deep on an average. The great need of this, as of the other upland soils, is more organic matter, and a rotation of crops should be arranged by which this end may be attained. Land broken in the fall should be sown to rye, which may be plowed under in the spring. A systematic rotation should be adopted, for instance, cotton one year, corn one year, and cowpeas one year, followed by fall-sown rye, to be turned under in the spring before cotton is planted. There is little fertilizer used on this soil at present. The price of land varies with location from \$5 to \$20 an acre.

The following table gives the results of mechanical analyses of fine-earth samples of the Fayetteville stony loam:

Mechanical analyses of Fayetteville stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16208-----	Soil-----	0.2	0.5	0.6	26.9	32.9	32.2	6.5
16290-----	Subsoil----	1.6	3.1	1.4	11.2	16.2	43.5	22.4

FAYETTEVILLE FINE SANDY LOAM.

The surface 8 to 12 inches of the Fayetteville fine sandy loam is composed of fine sand with varying amounts of silt and a small percentage of clay. There are small areas of the Fayetteville stony loam found scattered through this soil, and the typical areas may contain a small amount of fine gravel. The color of the soil is gray to reddish gray. The depth of the subsoil varies, but is usually from 10 to 20 feet. Some small areas are found where the underlying strata come within less than 4 feet of the surface. The subsoil is gray to reddish gray in color and is composed of fine sand and clay, and usually has a fine sandy clay texture. The soil is quite easily tilled, being loose and light for several inches below the surface.

The Fayetteville fine sandy loam is found in the northern part of the county. Near Center Ridge there are comparatively large tracts of it, as well as on Pigeon Roost Mountain and west of Jerusalem. The surface is generally level to gently rolling, and during an average season the drainage is good, but when the season is unusually wet there are some areas that may require ditching.

The Fayetteville fine sandy loam is derived from the weathering of fine gray sandstones of the Millstone grit formation. In contradistinction to the ferruginous material of this formation, giving rise to the stony loam, the rocks from which the fine sandy loam is developed are of light-gray color and held together by a siliceous cement, which, under the influences causing disintegration, seem to break down uniformly, leaving few or no fragments in the resulting soil. We thus have two soil types derived from essentially the same rocks, but having quite different compositions.

The native vegetation on this soil is essentially the same as that found on the stony loam, except that the development is generally better and more white oaks are noted. This is the best early truck soil in the uplands. It would also produce profitable crops of peanuts, as well as good crops of cowpeas and potatoes. The crops grown are corn and cotton. When new this land is capable of producing about 30 bushels of corn and about one-half bale of cotton to the acre, but after about twenty years' cropping without rotation

or manuring the producing power is reduced to a point where the yields are no longer profitable and the fields are "turned out." An average yield is about 10 bushels of corn and one-quarter of a bale of cotton to the acre. The cultural methods and crop rotations for this type are essentially the same as those recommended for the stony loam, except that the annual plowing should be somewhat deeper, because of the heavier subsoil and the different line of crops to which the soil is adapted. The price of this land is about the same as that of the stony loam.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Fayetteville fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16300-----	Soil-----	0.7	0.6	2.0	25.6	9.5	54.0	7.2
16301-----	Subsoil-----	.5	.5	1.8	19.4	5.9	52.6	18.7

FAYETTEVILLE LOAM.

The soil of the Fayetteville loam is composed mainly of fine sand and silt to a depth of about 8 inches. In color it grades from yellow to reddish yellow. It carries only a small proportion of organic matter. A little gravel is found on the surface in some places, but such areas are generally cultivated. The subsoil has good depth and always rests on more or less decomposed shale. In color the subsoil ranges from yellow to mottled-yellow and red. It carries a large quantity of silt and clay and many iron concretions are present in depressed areas.

This type is found largely in the southern part of the county, with only a small area in the northwest. The largest single area is found on Petit Jean Mountain, and the second largest near Morrillton. The surface of this soil is usually gently rolling, but some depressed places are found where drainage is deficient. The soil has a tendency to run together or puddle after a rain, and its peculiar structure causes it to become waterlogged easily. Water moves through it very slowly and stands on the surface many hours after a rain.

The Fayetteville loam is derived from the breaking down of shales which belong to the Coal Measures group. These shales are weathered deeply in places; in others the small streamlets have cut down to bed rock only a few feet below the surface. These shales are dark colored, while the resulting soil stratum is yellow to reddish yellow.

Most of this soil is now under cultivation, the native vegetation having been removed many years ago. It is apparent, however, that the original forest growth consisted of various kinds of oaks, similar

to those on the other soils of the area, though they appear to have had a better development. Among the smaller plants found on this soil the Japan clover is important.

This is a fairly strong type of soil and its great water-holding capacity fits it for a line of crops quite different from the drier soils of lighter texture. It is perhaps the best corn soil in the hill country and is equally adapted to grass and certain other forage crops requiring much moisture and a soil of medium close texture. Certain vegetables and fruits, such as potatoes, cabbage, strawberries, etc., may be grown successfully on this type. When heavily limed good yields of alfalfa may be secured, and it is recommended that this forage plant be used in a limited way on every farm containing this soil. Alfalfa is preferable to cowpeas on this type for forage purposes, but it will be found that a good stand of alfalfa is more easily secured following a crop of cowpeas.

The crops grown at present are corn and cotton. When fresh this land will produce about 30 bushels of corn and about one-half bale of cotton, but its productiveness soon declines with continuous cropping to hoed crops, showing the necessity of employing green manuring crops. The average yields are 15 bushels of corn and one-third of a bale of cotton to the acre.

This soil should be plowed deep and an effort made to keep it well supplied with humus. Liming is recommended and also a rotation of crops in which either grass or some leguminous crop shall follow the hoed crops once in every four years. This land now has an average value of \$25 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Fayetteville loam:

Mechanical analyses of Fayetteville loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16302-----	Soil-----	2.6	2.6	0.7	1.3	6.4	74.6	11.2
16303-----	Subsoil----	2.2	2.1	.5	1.1	3.2	69.7	21.6

ROUGH STONY LAND.

The Rough stony land is practically worthless for general agricultural purposes. It includes the various escarpments, stony breaks, deep gorges, and other broken surfaces that lie untouched in the hill country. There are, however, some slopes on the mountain sides where it would be possible, and sometimes quite feasible, to grow apples and grapes, though in general this land is too rough and too steep for the use of horses in cultivation.

This land lies principally in the northern part of the county. A considerable body is found, also, on Petit Jean Mountain, south of the river. There are many square miles of this type scattered here and there over the area.

CONWAY SILT LOAM.

The Conway silt loam is a transition type between the upland soils and those found along the streams. The soil is composed of very fine sand and silt. It has a rather close structure, and the color is generally yellow to gray, depending on the amount of organic matter present. The soil is about 6 inches deep, resting on a subsoil of similar texture, but of a yellow to nearly white color, which varies with the drainage conditions. The soil and subsoil frequently carry iron concretions, and in some places the subsoil shows an iron hardpan. The type is characterized by numerous mounds, ranging from less than 10 to more than 50 feet in diameter and from 2 to 6 feet in height. These mounds reduce greatly the agricultural value of the land.

The greater part of this soil is found in close proximity to the bottom lands in the southern part of the area. There is, however, a large body of it lying northeast of Morrillton on the uplands, considerably removed from the river. Small patches are found scattered at various places where conditions are favorable for its development. The areas are low and wet, have a gently rolling to flat surface, and are usually surrounded by higher ground, the drainage waters from which pass over this soil, producing conditions of poor drainage, and large areas must be ditched and tiled before cultivation can be carried on successfully. The water stands on or near the surface for long periods after rains and the water table is always near the surface.

Some of this type appears to be a true second bottom, while some other parts seem to have an origin similar to that of the Fayetteville loam and to be residual material derived from the weathering of shales. That found in close proximity to the river has doubtless been formed at an earlier period by river action, while that in the uplands appears to be a true residual soil, owing its present characteristics to its peculiar topographic position.

The native vegetation consists of a variety of oaks, prominent among which is the post oak. There are some shrubs, such for instance as the haw. Various lowland grasses are found. There is a large percentage of this type yet in its virgin state, and that which is under cultivation produces only indifferent yields of corn and cotton. The mounds that cover its surface so generally soon lose their fertility and appear as light spots that contain little or no

organic matter. Twenty bushels of corn and one-fourth bale of cotton are good average yields for this soil in its present condition. This type needs good drainage and heavy liming. The soil itself does not appear to be unproductive, but its poor physical condition prevents the true value of the land being brought out. When this condition shall be corrected the soil should be one of the strongest in the county and, by reason of its silty texture, well suited to such crops as cotton, corn, and vegetables, as well as to certain of the grasses. At present it may be used for pasture, and only the better drained areas for general crops. This land is now worth, on an average, less than \$10 an acre.

The following table shows the texture of the soil and subsoil of the Conway silt loam:

Mechanical analyses of Conway silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16294, 16296	Soil	0.8	0.9	0.5	8.0	12.6	64.4	13.3
16296, 16297	Subsoil	.2	1.1	.6	6.0	11.7	58.5	21.4

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16296, 1.86 per cent.

WABASH CLAY.

The Wabash clay is the heaviest soil in the county. It is composed very largely of clay, but contains considerable organic matter. It has a prevailing dark-brown to black color, though some limited areas of reddish-brown are noted. The soil has an average depth of about 12 inches. The subsoil is very similar in composition to the soil, except that it contains a smaller amount of organic matter and has a slightly lighter color. It is not known just how deep the subsoil is, but it is generally over 3 feet deep. This type of soil is difficult to cultivate and requires careful manipulation for the successful production of crops. It is said that a good crop is rarely harvested from it on account of its heavy, clayey composition.

The largest body of Wabash clay is found northwest of Morrilton, where the bottom lands along Point Remove Creek join those of the Arkansas River. There are other rather large areas in the river bottom proper, lying southeast of Morrilton and south and southeast of Plumerville. The surface of this soil is level to flat, and the drainage, both surface and textural, is generally inadequate. The water table often stands within 1 or 2 feet of the surface and the rainfall drains but slowly into the ditches.

This is an alluvial soil, and has been mostly deposited by the joint action of the flood waters of the Arkansas River and Point Remove

Creek. These flood waters meet in such way that a vast area of still water (back-water) is made at their junction and over this area the clayey sediments brought down by Point Remove Creek from the shaley areas in the mountains are forced to settle. In other parts of the bottoms these clayey areas mark old lake beds or old river channels where muddy waters have stood after a flood. The vegetation peculiar to this type consists of various kinds of water-loving oaks, willow, cypress trees, etc. In its present condition the production of corn and cotton has not been found profitable on most of this type. There are some local areas, however, where there is a substratum of fine sand not far below the surface, on which cotton and corn make a rank growth. But even here the cotton is apt to go to weed and the corn to stalk. As it stands now, in all probability, the most promising crop for this soil is some kind of a hay crop or rice. There is little doubt that the large area lying northwest of Morrilton will, in its present condition as to drainage, produce very profitable crops of rice. The land would of course have to be protected from floods, but there appears to be no physical difficulty in the way of profitable rice production. At the present time about the only crops grown are cotton and corn. Some farmers have attempted to grow alfalfa, but success with alfalfa on this soil is doubtful and in all probability the growing of this crop will soon be abandoned. Chemical test shows this soil to be low in lime, an element necessary to the successful growing of all leguminous plants. Perhaps the best method of handling this heavy clay consists of very deep plowing with the disk plow, heavy liming, and a good system of open and tile drains. Its productiveness when brought into good condition is great. The price of land of the Wabash clay type ranges from \$25 to \$50 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Wabash clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16309-----	Soil.....	0.0	0.2	0.7	8.9	4.2	58.2	32.8
16310-----	Subsoil....	.0	.5	.9	1.8	1.6	49.4	45.8

WABASH SILT LOAM.

The Wabash silt loam is composed very largely of silt. It also contains a rather large proportion of humus, which gives it a dark color. The soil is about 10 inches deep and overlies a subsoil composed of silty clay that becomes heavier with depth. The surface soil contains some fine sand, and this, together with the included organic matter, causes it to be cultivated with comparative ease.

The Wabash silt loam is located in the bottom lands, both along the rivers and the smaller streams. The largest development is found near the junction of the east and west forks of Point Remove Creek. The surface is gently rolling to flat. The areas found in the river bottom are generally well drained and under cultivation, while that lying south of Hattieville is poorly drained, even swampy, and yet in its virgin state. In order to protect this and most of the other soils of the bottom lands from inundation by the occasional high water in the streams a system of drains and levees will have to be constructed.

This is an alluvial soil formed, as in the case of the Wabash clay, from deposition in slowly moving water. The native vegetation consists of various oaks, such as the willow oak, water oak, together with elm, hickory, gum, etc. The more poorly drained parts of this type are found in close proximity to the large body of clay to the northwest of Morrillton, and here rice culture might be successfully practiced. In this part of the area drainage is needed before other crops can be produced. This soil, where it is well drained, as in some parts of the river bottom proper, is the most productive of the bottom-land types, and the best soil in the county for cotton and corn. Where the water table is from 5 to 10 feet below the surface, alfalfa may be produced with marked success. Care must be taken, however, to eradicate the Bermuda grass that prevails so generally on these bottom soils. The crops grown at present are cotton, corn, and some alfalfa. Under favorable conditions a bale of cotton and 60 bushels of corn to the acre are secured, and a fair average yield would be about two-thirds of a bale of cotton and 40 bushels of corn to the acre.

There is some complaint that cotton makes too much weed and too little lint, and that corn runs too much to stalk. While good yields are often secured they are occasionally much below what might be reasonably expected from so rich a soil. These facts suggest certain cultural methods which are applicable both to this and the clay soil. These soils should be plowed deeply with the disk plow and heavily limed. The cotton should be planted as early as possible; the rows should be wide apart, and should run north and south. When the plants are about ready to be laid by, the central stalk and all the main branches should be severely topped in order to check the growth of wood and cause the plant to set more fruit buds. Running the rows north and south will give the maximum of sunshine so necessary to make cotton open in this latitude. All these bottom soils are in need of more lime and its free application is recommended for all crops. It is also recommended in the production of cotton in the bottom lands that the check-row system be adopted in order to use modern machinery and thus reduce the cost

of production. This land, where it is under the plow, is worth about \$50 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Wabash silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16307-----	Soil-----	0.0	0.1	0.2	1.1	8.8	74.8	15.4
16308-----	Subsoil----	.0	.1	.2	1.9	5.8	68.2	23.8

WABASH FINE SANDY LOAM.

The soil of the Wabash fine sandy loam is composed of fine sand and silt intermingled with a fair amount of organic matter. It has an open structure and is quite easy to cultivate. The soil is about 11 inches deep, and rests upon a subsoil composed mainly of fine sand. Both the depth of the soil and the nature of the subsoil vary, but the type as a whole has a rather light texture. The color of the soil is reddish-gray, while that of the subsoil is reddish-yellow to gray.

The Wabash fine sandy loam is confined to the river bottom and is found lying either between the silt loam and the river or between the silt loam and the fine sand to be described later. It has its greatest development south and west of Morrilton and south of Plummerville. The surface is gently rolling and the light sandy subsoil allows excellent drainage. This soil is alluvial in origin, having been laid down by the river during flood seasons. The loamy nature is due to the shifting of the course of the stream channel by which fine silty sediments have been deposited on the fine sands that once marked the places of small islands and the immediate river bank where the overflow currents were swiftest.

Most of the native vegetation has been removed from this soil, but there is enough left to show that the pecan, the cottonwood, the sycamore, and the walnut were important. This soil is well suited to all crops that flourish in a well-drained, light soil. Hence, peanuts, early truck, sweet potatoes, etc., can be successfully grown on it. While the natural productiveness is not very great, the good physical condition of the soil results in fair crops of corn and cotton. One-half bale of cotton and 25 bushels of corn may be considered good yields, with an average of about one-third bale of cotton and 20 bushels of corn to the acre.

The Wabash fine sandy loam should be plowed with the ordinary share plow. A crop rotation should be adopted by which more organic matter could be added each year. Bermuda grass generally badly infests this type, and as this greatly increases the cost of pro-

duction steps should be taken to eradicate it. It should be turned under deeply—not a spear left on the surface—and some crop, such for instance as cowpeas, should follow to shade the land thoroughly for one or two summers. This grass could thus be destroyed and at the same time a profitable forage crop might be harvested. This land is worth about \$25 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Wabash fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16305.....	Soil.....	0.0	0.1	1.6	26.4	26.1	39.2	7.0
16306.....	Subsoil....	.0	.7	14.9	69.9	3.0	9.1	2.9

WABASH FINE SAND.

The Wabash fine sand is composed of a homogeneous fine sandy material generally over 3 feet deep. It is yellow in color and carries little organic matter. The structure is open and porous, and water soon passes down through it. The surface is rolling, and some small dunes are noted.

This type marks the sand banks and islands in the river channel, as well as the overflow areas lying immediately on the bank of the stream. The sand has been deposited by the annual flood waters and drifted into irregular shapes by the currents and by wind action.

Very little of this soil is under cultivation, as it is too light to grow crops, and where there are heavy phases its position with reference to the river is such that flood waters do the greatest damage. Some cotton is grown here and there upon spots having a heavier texture.

The following table gives the results of a mechanical analysis of a sample of the soil of this type:

Mechanical analysis of Wabash fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16304.....	Soil.....	0.0	0.0	0.1	76.0	19.0	3.4	2.3

SUMMARY.

Conway County, Arkansas, is located near the geographical center of the State and is traversed from west to east in its southern part by the Arkansas River. The Missouri Pacific Railway Com-

pany operates a line from Little Rock to Fort Smith through this area.

The surface of the county is gently rolling to rough and mountainous, Petit Jean Mountain being the highest elevation in the area. There is a broad valley along the Arkansas River, and here are found the best agricultural lands of the county. The area is well drained, except for a few thousand acres to the north and northwest of Morrillton. Here ditching and tile draining will be necessary for profitable production of crops.

While a number of colored people are found around the principal towns and scattered over the bottom lands, the great majority of the population is white and generally of southern origin. There are, however, a number of Germans, Swiss, and Italians.

The two most important towns are Morrillton, the county seat, and Plumerville. These have been built since the advent of the railroad in 1873. The county was formed in 1825, prior to which time it was a part of the Indian Territory.

Corn and cotton have been the staple crops from the earliest settlement, and prior to 1873 were shipped to market on the Arkansas River.

The one-crop system is still in use, although some of the farmers are beginning to diversify and to introduce some new crops, for instance, fruit and alfalfa. Little or no attention is given to crop rotation.

The soils of the area have been classified into nine types. Five of these are residual upland and four are alluvial bottom soils. The upland soils have been correlated with the Fayetteville series, and the bottom soils with the Wabash series.

Some of the upland soil types, notably the Fayetteville stony loam, are well suited to the production of apples where sufficient clay is found in the subsoil. There are phases of this type that could be used profitably in the production of peaches, provided a shipping point is sufficiently near.

The soils along the river are wholly different from those on the hills and require different treatment. Most of them are well suited to the production of cotton and corn and two types, namely, the Wabash clay and the Wabash silt loam, will grow good crops of rice in those areas where the surface is flat and the drainage somewhat poor. The Wabash silt loam, where the water table is from 5 to 10 feet below the surface, will grow good alfalfa. This is also true of the Wabash clay where good surface drainage can be secured.

SOIL SURVEY OF GILES COUNTY, TENNESSEE.

By ORLA L. AYRS and M. W. GRAY.

DESCRIPTION OF THE AREA.

Giles County is situated in the south-central part of Middle Tennessee adjoining the Alabama line. It originally occupied a nearly rectangular area extending 22 miles east and west and 30 miles north, but the transfer of several square miles from the northeastern corner to Marshall County has given that portion an irregular outline. It is bounded on the north by Maury and Marshall counties, on the east by Marshall and Lincoln counties, on the south by Alabama, and on the west by Lawrence County.

The county includes portions of the two physiographic divisions commonly known throughout Middle Tennessee as the Highland Rim

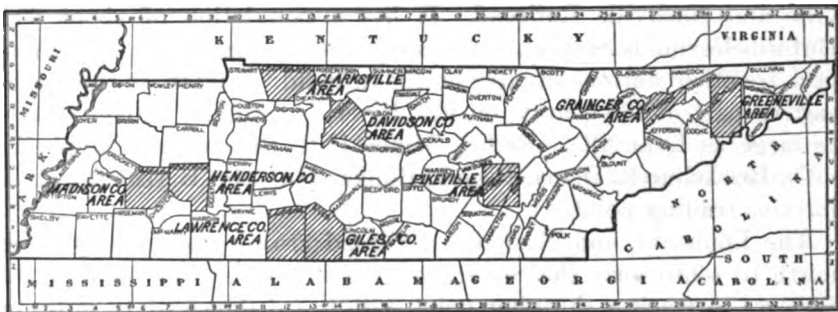


FIG. 25.—Sketch map showing location of the Giles County area, Tennessee.

and the Central Basin. At the junction of these two divisions much of the county is rough and broken. The range in elevation is from 600 to 1,000 feet above sea level. The county is drained by Elk River and its tributaries, the principal one being Richland Creek. Elk River enters the county from the east at a point about 8 miles north of the State line and follows a general southwest course, leaving the county near the center of the southern boundary line. Richland Creek enters the county near the northeast corner and flows west to Buford, where it is joined by one of its principal tributaries, Richardsons Fork, and turns south, following first a southwest then a southeast course to its junction with Elk River near the southern boundary of the county. These streams flow through broad valleys with low, rolling hills. Toward the sources of the tributary streams the hills become higher and steeper and at the headwaters the country

is very rough and broken, presenting a variation in elevation of 150 to 250 feet.

The first settlement was made near the mouth of Richland Creek in 1807. Settlers from the eastern part of the State, North Carolina, and Virginia came in rapidly and the county was established by the State legislature in 1809. Provision was made to locate the county seat near the center of the county. The present site of Pulaski was selected in 1810 and the town was founded the following year. The first settlers located in the valleys of Elk River and Richland Creek and this region was developed quite rapidly, while the rougher portion of the county along the west side received little attention until years later. The county has a large negro population at the present time. There has been very little immigration for many years and the greater proportion of the inhabitants are descendants of the first settlers. In 1900 the population was 33,035.

Pulaski, the county seat, is situated near the center of the county on the Louisville and Nashville Railroad. It is a thrifty business place, with a population of about 4,000. Lynnville, the second town in importance, is in the northern part of the county on the Louisville and Nashville Railroad. It has a population of about 500. Buford, Reynolds Station, Riversburg, Wales, Aspen Hill, and Prospect are other stations situated on the railroad. Elkton, in the southeastern part of the county, on Elk River, is a thrifty village nearly as large as Lynnville. Bethel, Minor Hill, Bodenham, Campbellsville, Brickchurch, Diana, Pisgah, Bunker Hill, and Bryson are other interior trading points.

The Louisville and Nashville Railroad crosses the country from north to south near the center, making it possible for most of the farmers to reach a shipping point within a distance of 10 miles or less. The county has over 800 miles of roads. Forty-five miles are toll pikes and about 450 miles are under county control. Of the latter about 50 miles have been surfaced with gravel and are as well kept as the toll pikes.

Beds of excellent gravel are found along all the streams and there is an abundance of limestone and other rocks suitable for road building in all parts of the county. With this unlimited supply of material good roads can be built at a relatively low cost.

The county is about 65 miles south of Nashville, from which it receives most of its supplies. Some of the products are marketed there, but a great deal is shipped to small markets. Milling companies in the county and at Columbia, in Maury County, use a considerable portion of the corn crop, although much corn is shipped to small towns in Alabama and other States farther south. The lumber output of the county at the present time is quite large.

CLIMATE.

The climate of this region is very favorable for general agriculture, and it is possible to grow a wide range of crops. The summers are long, and during July and August there is usually a period of hot weather lasting several weeks when the temperature is seldom less than 80° F. The winters are mild, with very little extreme cold. Occasionally the thermometer falls to zero or below, but periods of low temperature are of short duration.

The tables below consist of data compiled from the records of the Weather Bureau station at Lynnville in the northern part of the county. From the first table it will be seen that there is an average period of six and a half months free from frost, although in one instance (that of 1899) this time was shortened by nearly a month. The annual rainfall, 53.55 inches, is ample for all agricultural purposes and is evenly distributed throughout the year.

Dates of first and last killing frosts at Lynnville.

	Last in spring.	First in fall.		Last in spring.	First in fall.
1898	Apr. 8	Oct. 23	1902.....	Apr. 8	Oct. 29
1899	Apr. 11	Sept. 27	1903.....	Apr. 5	Oct. 25
1900	Apr. 1	Nov. 4	1906.....	Apr. 2	Oct. 11
1901	Apr. 4	 do..	Average.....	Apr. 6	Oct. 22

Normal monthly and annual temperature and precipitation at Lynnville.

Month.	Temper- ature.	Precipi- tation.	Month.	Temper- ature.	Precipi- tation.
	° F.	Inches.		° F.	Inches.
January.....	38.4	4.94	August.....	77.3	4.14
February.....	40.1	5.20	September.....	70.9	3.80
March.....	49.6	6.28	October.....	60.0	2.63
April.....	58.3	4.46	November.....	48.6	3.44
May.....	58.4	4.35	December.....	41.0	4.71
June.....	75.6	4.36	Year.....	58.9	53.55
July.....	78.8	5.24			

AGRICULTURE.

The early settlers in Giles County were a long distance from any market, and the inadequate methods of transportation made it necessary to produce at home nearly everything needed by their families and to raise for export only such things as could be easily transported for long distances. These conditions resulted in the growing of a wide range of crops. Besides the general farm and garden crops, flax, hemp, indigo, and rice were grown. Cotton was early introduced, as is shown by the establishing of a gin at Lynnville in 1811. Not much cotton was grown for market, however, until after the

close of the war of 1812. Much of the early product was sold without being ginned. Tobacco was cultivated for the market from 1816 to 1821, when declining prices caused its production to be discontinued. Hemp was grown for the market from 1811 to the close of the civil war. These early products were shipped out by means of flat-bottom boats, built along Richland Creek and Elk River and floated down stream to the distant market. This practice was discontinued about 1840. The dense undergrowth of cane in the forest afforded an abundance of pasture and stock ranged at liberty over the country. Until the commencement of the civil war cattle raising was the most remunerative industry in the county.

The completion of the Louisville and Nashville Railroad across the county about 1860 made it possible for the farmers to ship their products much quicker than had been done and to obtain elsewhere commodities it had been necessary to produce for themselves theretofore. The change in the agricultural conditions of the county following the civil war was not as marked as in many sections of the South.

At the present time general farming is the rule. On the Hagerstown soils nearly every farmer cultivates several crops and keeps some live stock. The conditions on the Clarksville soils are not as good. Corn and cotton and a few acres of wheat or an occasional patch of cowpeas are the usual crops. Very little live stock is kept.

Corn is the principal crop, the acreage planted to it always being greater than that in wheat and cotton, the crops next in importance. In 1899 there were 85,294 acres in corn, while the total for wheat and cotton was only 48,691 acres. The average yield of corn for the county is a little over 21 bushels per acre. According to the census of 1900 the total acreage in wheat for the county was 32,226, with an average yield of slightly over 8 bushels per acre, while in cotton there were 16,465 acres producing an average yield of three-eighths bale per acre. Better prices since then have caused an increased acreage in cotton, and at the present time it will nearly equal that of wheat. Oats are grown to a limited extent, but do not form one of the important crops of the county. Clover is well adapted to the soils of the county, but owing to the ravages of a fungous disease in recent years little is now sown.^a Cowpeas take its place largely both as a hay crop and a soil renovator. There is a large acreage of sorghum, millet, and other grasses cut for hay each year. Vegetables and small fruits are grown for local use. Apples and peaches do very well on the Clarksville soils, but owing to the damage done by late spring frosts are an uncertain crop.

In the valleys the live-stock industry is quite important. There is very little full-blood stock, but the breeds of both cattle and hogs

^a Bulletin 75, Tennessee Agricultural Experiment Station.

have been improved until they compare favorably with the grade stock of other sections of the country. Most of the cattle have been bred toward the beef type, but dairying has received some attention and a creamery is operated at Pulaski. On the Highland Rim less care has been taken and the native breeds predominate.

In the valleys the adaptation of the different soils to different crops is recognized to some extent. The bottom lands are planted largely to corn. The Hagerstown loam and Davidson loam are planted to cotton and general crops, while the steeper slopes of the Hagerstown stony loam are used largely for grazing. Little attention is given to selection of crops best suited to the Clarksville soils.

Very few of the farmers practice a systematic rotation, although the injurious effects of growing the same crop continuously on a given piece of land are generally recognized and most of them change their crops from field to field without following any regular order.

Improved methods are in evidence over a large part of the county. Many of the farms are equipped with riding plows, disk harrows, binders, and other modern farm machinery. The farm dwellings are well built, and there are many handsome country homes scattered over the county. The outbuildings are not so well kept. Work stock is usually well cared for, but owing to the mild winters cattle are frequently allowed to go without shelter. Most of the farms are inclosed with good fences. The use of wire for this purpose is becoming quite general.

The greater part of the work on the farm is performed by the owner or tenant. Where labor must be hired, negroes are usually engaged and are fairly efficient. Some difficulty is experienced in getting help, as the phosphate mines in this and adjoining counties pay higher wages than can be obtained on the farm. Farm laborers receive from \$15 to \$20 a month. A house is usually furnished the man and his family and he is given firewood and a small garden.

According to the Twelfth Census the average size of farms in the county is 79.7 acres, and 49.3 per cent of the farms are operated by owners. There are many holdings, however, of 200 to 500 acres. These large farms are operated wholly or in part by tenants on shares. On many farms the tenant furnishes everything and receives two-thirds of the crop, and in other cases the landlord furnishes half and the tenant half and each receives half the crop.

According to the Twelfth Census, Giles County has 340,702 acres in farms which, together with the improvements, except buildings, have a total value of \$4,445,400, or an average value of \$13.05 per acre. However, the land values vary widely, ranging from \$2 or \$3 to \$100 an acre, depending largely on the difference in the producing power of the different soil types in the county.

The greatest need is an increase in live-stock production, so that the grain and hay can be fed on the farm and the manure returned

to the soil, allowing only the finished products in the form of meat, butter, etc., to go on the market. By doing this the crop value of the basin soils could be maintained indefinitely, and under good management their producing power could be increased. On the Highland Rim organic and other manures are more necessary than on the bottom soils.

The subject of rotation of crops is one to which the farmer should give greater attention. Each farmer can adopt a system especially suited to his needs, but every rotation should include three things—a cultivated crop, a hay crop, and pasture.

SOILS.

The region occupied by Giles County was in past geologic time part of a plateau which extended far beyond the limits of this survey. The surface of this plateau was made up of the St. Louis limestone^a and the Tullahoma formation occurring at the base of the Carboniferous system. During a long period of time active erosion has been going on, cutting away the plateau and exposing the underlying rocks as far down as the Lebanon limestone in the Lower Silurian. Only a remnant of the original plateau now remains. This is known as the Highland Rim of Tennessee and has an elevation of 900 to 1,000 feet above sea level. The older streams have nearly reached their base level of erosion and have developed broad valleys with gentle slopes and low, rolling hills, while large areas of bottom land have been built up along their courses. The smaller streams are still actively at work and extend back into deep, narrow valleys, separated by rugged, irregular, and very much broken ridges whose crests reach nearly or quite to the elevation of the original plateau. Where these conditions exist the country presents a rough, broken appearance.

The soils of the county fall naturally into two main divisions, the residual and alluvial. The former, covering by far the greater part of the county, are the result of the disintegration and decomposition of the various rocks. The alluvial soils consist of reworked material carried down by water and deposited as bottom lands along the streams. The residual soils fall into two quite distinct groups owing to a marked difference in the parent rock from which they are derived.

The members of the Carboniferous system consist of impure silicious and cherty limestones which give rise to the Clarksville series. The rocks occupying the surface of the plateau have weathered into a deep gray to yellowish silt loam containing very little rock fragment. This

^a The geological names used here are those used for equivalent formations in the Columbia Folio of the U. S. Geological Survey.

has been called Clarksville silt loam. Where the St. Louis limestone contained a relatively small percentage of impurities decomposition was more complete, producing a red soil—the Decatur silt loam. Where these formations were subject to erosion much of the fine earth was carried away, leaving an accumulation of rock fragments and cherty material incorporated in the soil on the steep slopes. This has given rise to the Clarksville stony loam. This type covers a large part of the county, occurring as rough, broken ridges, and in deep narrow valleys.

The lower lying Silurian formations consist of nearly pure limestone, from which the Hagerstown series is derived. Farther down the valleys and around the points of projecting ridges where the Silurian rocks are exposed below the Carboniferous, erosion has also been active, the finer material has been removed to some extent, and another stony type, the Hagerstown stony loam, has resulted. This type usually occurs as a band extending around the base of hills and up the valleys. At several points in the central and southern parts of the county the limestone from which the Clarksville soils are derived has been entirely removed and the Hagerstown stony loam reaches to the tops of the ridges.

Passing out into the broad valleys along the large streams, where the topography is less rough and broken, erosion has been less severe, the soil is deeper, and contains few rock fragments. Where this material has been derived entirely from the limestone it is called Hagerstown loam. At several points in the eastern and southern parts of the county there is a fine-grained brown sandstone and brown sandy shale interbedded with the limestone. These rocks have exerted a modifying influence on the soil to such an extent as to produce another type described as Davidson loam.

The large streams have built up along their courses rich alluvial lands, called Huntington silt loam. Passing up the tributary streams, the bottoms become narrower and are modified by an accumulation of gravel brought down from the adjoining hills. This type is known as Huntington gravelly loam.

The names and extent of the several types of soil are given in the following table:

Areas of different soils.

Soil.	Acres.	Percent.	Soil.	Acres.	Percent.
Clarksville stony loam.....	161,408	41.0	Huntington gravelly loam...	14,464	3.5
Hagerstown stony loam	88,072	21.2	Rough stony land	6,656	1.7
Hagerstown loam.....	58,888	13.7	Decatur silt loam	960	.3
Huntington silt loam.....	36,928	9.4	Guthrie silt loam	128	.1
Davidson loam	20,352	5.2	Total.....	398,216	.....
Clarksville silt loam	15,380	3.9			

HAGERSTOWN LOAM.

The soil of the Hagerstown loam to a depth of 10 inches is a dark-brown silty loam which in some cases becomes quite heavy, approaching a clay loam. The subsoil varies from a brown or reddish-brown to yellow clay loam, which frequently grades into a clay below 2 feet. The soil usually contains sufficient humus to make it loose and mellow when properly cultivated. If plowed when wet it is likely to clod.

The type is found in the central and southern parts of the county, where it occupies the less broken portions of the Richland Creek and Elk River valleys. It occurs as low, rolling hills and gentle slopes at the foot of steep hills. The topographic features are such as to insure good natural drainage, though very little erosion takes place.

The Hagerstown loam is a residual soil derived from the weathering of massive gray and blue limestone of Silurian age. Most of this limestone contains phosphate, and in some cases the quantity is so great that beds of commercial phosphate are left as a residue from the weathered rock. The soil is naturally rich in phosphate and is locally known as phosphate land.

This soil was originally covered with a heavy timber growth of oak, elm, hickory, walnut, and other hardwoods, beneath which was a dense growth of cane. The greater portion of the Hagerstown loam has been under cultivation for years, and very little of the original forest now remains. It is an ideal soil for general farming, and all of the standard crops can be grown to advantage. Corn yields 25 to 40 bushels per acre, wheat 15 to 25 bushels, and cotton one-half to three-fourths bale per acre.

This soil should be plowed at least 8 inches deep, and the occasional use of a subsoil plow to loosen it to a greater depth would doubtless prove beneficial. Commercial fertilizers are not needed. There is a tendency to keep the fields in cultivated crops too long. Some rotation should be practiced which would include cowpeas or clover, so as to avoid the loss of organic matter.

Farms on this type range in value from \$25 to \$60 an acre, according to location and character of improvements.

The average results of mechanical analyses of samples of soil and subsoil of the Hagerstown loam are given in the following table:

Mechanical analyses of Hagerstown loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18139, 18141	Soil.....	0.7	3.1	1.4	5.6	9.3	55.8	23.8
18140, 18143	Subsoil	2.2	5.0	1.3	5.5	6.8	44.0	34.4

DAVIDSON LOAM.

The surface soil of the Davidson loam consists of 8 to 10 inches of brown to reddish-brown loam. It usually contains a noticeable quantity of fine sand, which in a few cases causes it to approach a fine sandy loam. The subsoil is a heavy reddish-brown loam, grading into a clay loam.

This is one of the less extensive types of soil in the county. The principal areas are found in the northeastern part in the vicinity of Brickchurch, extending west to Buford, and in the southern part in the Elk River Valley. It is closely associated with the Hagerstown loam and occupies the same topographic position. It is more easily injured by erosion, and a few neglected places have been damaged in this way. Like the Hagerstown loam, it is a residual limestone soil, but in this case a fine brown sandstone and reddish-brown sandy phosphatic shale are interbedded with the limestone. The modifying effect of these rocks produces the difference between the soils.

The native growth and crops cultivated on the Davidson loam are the same as on the Hagerstown loam. There is very little difference in crop yields on the two types. The Davidson loam is said to be the first to suffer from drought during long periods of dry weather. It is perhaps better suited for truck crops, but neither soil can be considered as ideal for this purpose.

The average results of mechanical analyses of this type of soil are shown in the following table:

Mechanical analyses of Davidson loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18123, 18126	Soil.....	0.8	3.4	4.9	19.3	6.4	49.9	16.1
18124, 18126	Subsoil	.5	3.3	4.3	13.7	5.7	47.6	24.6

HAGERSTOWN STONY LOAM.

The Hagerstown stony loam consists of 8 inches of heavy, brown silty loam overlying a light-brown or yellow clay loam or clay, which is usually heavier than the subsoil of the Hagerstown loam. The surface is strewn with fragments of weathered, massive limestone, varying from an inch to a foot or more in diameter. A considerable quantity of this rock fragment is also incorporated in the soil and subsoil. On steep slopes, where the Clarksville stony loam lies above it, angular fragments of chert have crept down upon the Hagerstown stony loam and added to the rock débris on the surface.

This soil is found throughout the eastern and central parts of the county and in a few small areas well toward the west line. It occurs

as rough, broken hills and narrow bands running along the steep valley slopes above the Hagerstown loam. During rains the water flows swiftly down the steep slopes of these hills, and where care has not been taken to protect the surface considerable damage has been done by washing. Because of this, a considerable portion of the type is kept in bluegrass and used for pasture.

Like the Hagerstown loam, this soil is the result of weathering or decomposition of Silurian limestone. Because of its steep, broken surface the fine earth has been carried away more rapidly than from the gentler slopes of the lower valley land, and the more resistant portions of the parent rock have been left. This accumulation of rock fragments has given the soil its present stony character.

The Hagerstown stony loam is adapted to crops much like those grown on the Hagerstown loam. The yields are not quite as large, and more difficulty is experienced in cultivating this soil. Where corn and cotton are grown it is necessary to have the rows follow a nearly level line around the hills to prevent washing. This practice of contour cultivation is quite general and satisfactory, so that terracing is not necessary. While much of this land is used for pasture, it would seem advisable to keep still more of it in grass. The returns from stock raising would doubtless be greater than could be obtained from cultivated crops. Its present value varies from \$15 to \$40 an acre.

The average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Hagerstown stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18133, 18135.....	Soil.....	2.4	4.2	1.9	4.1	2.5	64.6	20.6
18134, 18136.....	Subsoil.....	2.4	3.8	1.7	3.5	2.8	57.9	28.4

CLARKSVILLE STONY LOAM.

The Clarksville stony loam, to a depth of 8 inches, varies from a gray to light-yellow or light-brown loam, usually quite silty, sometimes becoming a silt loam. The subsoil is a yellow to reddish-yellow heavy loam or clay loam. Both soil and subsoil contain a large quantity of angular chert fragments, varying in size from an inch or less to blocks a foot or more in diameter. At the foot of steep slopes there is frequently an accumulation of this broken rock sufficient to prevent cultivation. The subsoil rests upon a mass of broken and partly decomposed rock, which is frequently encountered at a depth of 2 feet.

This is the most extensive soil type in Giles County. It occupies the greater part of the west half of the county, while other extensive

areas are found in the northeast and east-central parts. Smaller isolated areas are found capping high ridges throughout the remainder of the county. In the western part of the county it occupies rough, broken ridges intersected by deep, narrow stream valleys. Farther east the country is still rough and broken, but the Clarksville stony loam is confined to the tops and upper slopes of the ridges, while a band of Hagerstown stony loam occupies the lower valley slopes. The rough, broken topography of this type insures good drainage, and when left unprotected it is damaged by washing.

The Clarksville stony loam is a residual soil derived largely from the weathering of the Tullahoma formation, which is the lowest of the Carboniferous system in this region. This formation consists of siliceous and cherty limestones, with occasionally interbedded layers of shales. It is probable that the St. Louis limestone has also contributed to the formation of this soil.

A large percentage of this soil is still covered with the original forest growth, consisting of several species of oak, poplar (tulip tree), beech, hickory, walnut, elm, rock maple, and an occasional basswood. Corn is the principal crop. Wheat and cotton are also produced in limited quantities. Corn yields 15 to 30 bushels per acre. The yield varies with the position of the type, the lower slopes and bottoms of the narrow valleys being the more productive. Wheat yields from 5 to 15 bushels, and cotton from one-fourth to one-half bale per acre. No rotation is followed on this soil, and after a few years the quantity of organic matter greatly decreases. Hence the yields rapidly diminish and commercial fertilizers are resorted to to keep up the productiveness.

Sweet potatoes, cantaloupes, small fruits, and other truck crops do well. Apple and peach trees also bear well on this soil and produce fruit of good quality. The steeper slopes wash badly after having been cultivated a few years, and will prove more profitable if kept in permanent forest.

The Clarksville stony loam ranges in value from \$5 to \$20 an acre.

The average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Clarksville stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18117, 18119	Soil	1.6	3.3	1.4	3.4	5.0	67.2	17.7
18118, 18120	Subsoil	2.8	4.2	1.5	2.8	7.0	59.9	21.5

CLARKSVILLE SILT LOAM.

The soil of the Clarksville silt loam, to an average depth of 10 inches, is a gray to light-yellow silt loam. When dry it has a flour-

like feel, and when wet it is compact and somewhat plastic, being easily puddled, so that it becomes almost impervious to water. The subsoil is usually a compact silt loam resembling the soil but somewhat heavier. It is usually yellow, but in some cases is red or reddish-yellow, and it generally grades into red silty clay below 2 feet. This condition is particularly noticeable in the area near Elkmont Springs in the southeast corner of the county. The type is usually free from stone, though occasionally a limited quantity of chert is found scattered over small areas.

Although the Clarksville silt loam is one of the principal types of soil found on the Highland Rim, it has only a limited distribution in Giles County. Several large areas occur in the western part of the county, occupying the tops of broad ridges, and smaller areas are found in the east-central part on the ridge forming the divide between Pigeon Roost and Buchanan creeks. Another body near Elkmont Springs, in the southeast corner of the county, forms a part of a large area which extends beyond the limits of the survey east into Lincoln County and south into Alabama.

The Clarksville silt loam has a level to gently undulating surface, and is a remnant of a large plateau which at one time extended over this entire region.

Owing to the close, nearly impervious structure of the soil and its nearly level surface the ground water moves very slowly, but as the type occupies the tops of ridges usually less than a half mile in width the surface slope is generally sufficient to carry off drainage water.

This is a residual soil derived from the decomposition of St. Louis limestone and the upper members of the Tullahoma formation. These rocks contained a large amount of siliceous material which has accumulated in the soil. Owing to its nearly level surface very little of the residual material has been carried away by erosion, and the soil mass is much deeper than on the adjacent Clarksville stony loam. Bed rock is seldom encountered nearer the surface than 10 feet, and frequently not until a depth of 50 feet or more has been reached.

The greater portion of the Clarksville silt loam is still wild land covered with a stunted growth of several species of oak, black gum, sweet gum, chestnut, and poplar. Beneath this there is usually a scattered growth of blackberries, huckleberries, and other shrubs, broom sedge, and several wild legumes. Owing to the stunted appearance of the vegetation the areas occupied by this soil are generally known as the "barrens."

The crops generally grown are the same as on the Clarksville stony loam, with yields slightly smaller. In recent years efforts have been made in other parts of the State to use this soil for special crops. Strawberries and other small fruits have been grown successfully. Sweet potatoes do well, and the phase having a red subsoil produces

a Rockyford cantaloupe which is of exceptionally fine quality. The Clarksville silt loam seems to be well adapted to crops of this kind where quality rather than quantity is the feature most desired. Even molasses obtained from sorghum cane produced upon this soil is found to be far superior in quality and color to that obtained from cane grown on the Hagerstown soils.

Owing to the tendency of this soil to pack, a special effort is necessary in handling it to maintain a deep, loose, mellow seed bed. The depth of plowing should be increased to at least 10 inches and an abundance of organic matter should be supplied to keep it in a loose, loamy condition. The best way to accomplish this is to adopt some rotation which will include cowpeas every second year either as a hay crop or as a catch crop planted between the rows of corn or other cultivated crops. The soil generally shows a slightly acid condition, which can be corrected by applying lime at the rate of 2,000 pounds per acre.

The greater portion of the Clarksville silt loam ranges in value from \$5 to \$15 an acre.

The following table gives the average results of mechanical analyses of samples of this soil type:

Mechanical analyses of Clarksville silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18111, 18115	Soil	1.0	2.6	1.6	3.3	4.6	69.8	16.8
18112, 18116	Subsoil	1.0	2.7	1.4	3.1	6.2	64.4	20.7

DECATUR SILT LOAM.

The Decatur silt loam consists of 6 to 12 inches of reddish-brown silty loam, underlain by a reddish-brown silt loam grading into a deep-red silty clay. This type is usually free from stone, but in a few instances fragments of chert are found in both soil and subsoil. The Decatur silt loam is usually associated with the Clarksville silt loam. The transition from one to the other is gradual, usually extending over a wide strip.

This type has a limited development in the present survey. A few small areas are found about 2 miles south of Campbellsville in the northwestern part of the county. One area occurs at the top of Anthony Hill, southwest of Pulaski, and others are found near Krapp Springs, in the east-central part of the county and near Elkmont Springs at the southeastern corner. The surface is level to gently undulating, the only noticeable difference from that of the Clarksville silt loam being the presence of occasional sink holes.

Like the latter type it is a residual soil, but it is probably derived entirely from the St. Louis limestone and represents portions of that formation containing less siliceous matter, so that the resulting decomposition has been more complete.

The original forest growth is the same as that found on the Clarksville silt loam, but does not present the stunted appearance so noticeable on the latter type. The principal crops grown are corn, wheat, and cotton. Corn yields 20 to 40 bushels per acre, wheat 10 to 20 bushels, and cotton about a half bale. What has been said in regard to special crops for Clarksville silt loam and methods of handling that soil apply in a general way to this soil as well. The finest Rockyford cantaloupes produced in the State have been grown on farms marking the line of transition from one of these types to the other.

The Decatur silt loam ranges in value from \$10 to \$30 an acre.

The following table gives the average results of mechanical analyses of this type of soil:

Mechanical analyses of Decatur silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18129, 18131	Soil	0.3	2.2	1.2	4.5	4.0	68.7	18.4
18130, 18132	Subsoil	.3	1.6	.9	2.5	1.8	59.2	33.4

HUNTINGTON SILT LOAM.

The soil of the Huntington silt loam is a rich, mellow, dark-brown to chocolate-brown heavy loam to silt loam having an average depth of 12 inches. It contains a greater quantity of humus or organic matter than any other soil in the county. The subsoil is usually somewhat heavier, occasionally becoming a clay loam. It varies in color from light brown or yellow to dark brown, and occasional small areas are found where it is quite black. The high content of humus keeps the soil loose and mellow, so that it is cultivated with greater ease than the neighboring upland types.

This type consists of the bottom lands along Elk River, Richland Creek, Sugar Creek, and their larger tributaries. It occupies a level position from 5 to 15 feet above the normal level of the streams, but much of it is subject to overflow during periods of high water. During the growing season the mellow character of the soil admits of free movement of soil water, while the proximity to the streams insures the rapid removal of surface water, so that the natural drainage is usually sufficient. Occasionally heavy rains in the summer cause flooding for a short time, but this is by no means common.

The Huntington silt loam is of recent alluvial origin and consists of material washed from the adjoining limestone hills and deposited by the streams during periods of high water. Much of it receives a fresh coating of silt and organic matter during the periods of flood each winter and spring.

The type was originally covered with a heavy growth of oak, elm, hackberry, gum, and sycamore, and a dense undergrowth of cane. Practically all of the type is now under cultivation. Corn is the principal crop, yielding from 40 to 70 bushels per acre. Near Pulaski it is used quite largely for pasture and some portions of it are seeded in grass for hay. Wheat is likely to be injured by the winter flooding and is not generally grown. A large vigorous cotton plant is obtained, but the yield of lint is not equal to that secured from the plants on the upland soils.

Commercial fertilizers are not used. The frequent coating of sediment which the Huntington silt loam receives in times of flood in a large measure takes the place of manures, so that it can be cropped continuously for long periods, making it the most valuable type of soil in the county. It has a present value of \$40 to \$80 an acre.

The following table gives the average results of mechanical analyses of a sample of the soil and subsoil of this type.

Mechanical analyses of Huntington silt loam.

[Fine earth.]

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18153, 18155	Soil	0.0	0.3	0.2	1.6	3.7	75.4	18.0
18154, 18156	Subsoil	.1	.6	.4	3.1	7.6	64.4	25.3

HUNTINGTON GRAVELLY LOAM.

The Huntington gravelly loam, though variable in texture and color, in the main consists of 10 inches of brown loam or silty loam containing a considerable quantity of gravel, underlain by material having a similar texture but usually lighter in color and containing a larger quantity of gravel. At a depth of 2 to 4 feet a solid bed of gravel and broken rock is encountered. This is frequently cemented together, forming a light gray conglomerate. The gravel content of the soil is quite variable, in some cases being almost lacking in the first 30 inches.

Like the Huntington silt loam, this is a bottom-land type but differs from the former in being confined to narrow strips along the smaller streams. The surface is level or gently sloping from the stream to the foot of the adjacent hills. The valleys are usually

quite narrow with steep sides rising from the margin of the bottom land. The soil of the Huntington gravelly loam is formed by the wash from these hills. Gravel and fragments of rock frequently several inches across have been carried down the steep hillsides by the combined action of water and gravity, accumulating at the bottom and producing the gravelly character of the soil. In the western part of the county where the Clarksville stony loam extends down to the bottom of the valley this type is sometimes found in bottoms an eighth of a mile wide. Here the soil is usually lighter in color, the subsoil sometimes being gray. In other parts of the county where the Hagerstown soils occupy the lower valley slopes the Huntington silt loam extends farther up the streams, leaving the Huntington gravelly loam as very narrow strips near the heads of the valleys.

The native timber growth was the same as that of the Huntington silt loam and the same general crops are grown but the yields are not as large. Cotton, however, does better than on the latter type. Nearly all of the Huntington gravelly loam is under cultivation at the present time. Occurring as it does in narrow strips it is usually combined in farms with other types of soil which control the value of the whole.

The following table gives the average results of mechanical analyses of fine-earth samples of this type of soil:

Mechanical analyses of Huntington gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18147, 18149	Soil	3.7	10.4	4.6	11.9	7.8	41.7	19.4
18148, 18150	Subsoil	4.7	9.8	4.6	11.9	7.1	37.0	25.0

ROUGH STONY LAND.

The term Rough stony land has been applied to areas in this county where there are frequent rock outcrops and bed rock is only a few inches below the surface. These areas occur as caps to hills or bands running around the ends of ridges. In some cases they are steep stream bluffs.

These rocky areas generally cover only a few acres, but a few extend over a hundred acres or more. They are found in nearly all parts of the county, being most noticeable in the central and southeastern parts. The Rough stony land is usually associated with the Hagerstown stony loam. A few areas are found in the Clarksville stony loam.

Many of the areas in the central part of the county are covered with a growth of red cedar and are known as Glade land or Cedar glades.

Where there is no cedar the rough stony land is usually covered with a sparse growth of oak and other hardwoods. Grass grows on the shallow soil and affords some pasture.

GUTHRIE SILT LOAM.

The Guthrie silt loam consists of about 7 inches of light-gray silt loam underlain by a grayish-white plastic silt clay. In this county it is confined to one small area in the southeast corner. It occupies a wet, swampy, poorly-drained place included within the Clarksville silt loam and has no agricultural importance.

SUMMARY.

Giles County is situated in the south-central part of Middle Tennessee. It includes portions of the Highland Rim and Central Basin. The portion belonging to the Highland Rim is rough and broken, while that of the basin consists of low, rolling hills. The county is drained by Elk River and its tributaries.

The first settlement was made in 1807, the county established in 1809, and the county seat located at Pulaski in 1811. The early settlers came from East Tennessee and North Carolina. There has been little immigration into the county for many years, and most of the inhabitants are descendants of the first settlers. The population in 1900 was 33,035.

The county is traversed from north to south by the Louisville and Nashville railroad. There are over 800 miles of road in the county, about 100 miles being toll pikes and gravel roads.

The climate is favorable for general agriculture. The growing period free from frost is about six and one-half months. The average annual rainfall of 53.55 inches is evenly distributed throughout the year.

The early settlers cultivated a greater variety of crops than is grown at the present time. Cattle were the principal export product. At the present time corn, wheat, and cotton are the most important crops. In the valleys the live-stock industry is quite important. Cattle and hogs have improved in grade until they compare well with stock in other sections.

The adaptation of soils to crops is recognized to some extent. Very few farmers practice a systematic rotation, and crops are changed from field to field without following any fixed order. More attention should be given to crop rotation.

Improved methods of farming are quite generally employed. Many farms are equipped with modern machinery, buildings are well kept, and most of the farms are well fenced.

The greater part of the work on the farm is performed by the owner or tenant. Where extra help is needed negroes are usually employed. Farm laborers receive \$15 to \$20 a month with house and garden.

About half the farms are operated by the owners. Land is usually rented for a share of the crops, two systems being used. When the tenant furnishes everything he receives two-thirds of the crop, and when he furnishes half and the landlord half each receives half the crop.

The average price of land for the county is \$13 an acre, but prices vary from \$2 to \$100 an acre.

The present system of farming tends to lessen yields. More live-stock should be kept, so that crops may be fed and the manure returned to the soil.

The soils of the county, with the exception of the bottom lands along the streams, are of residual origin. There are two general divisions—those of the Highland Rim derived from the siliceous limestones of the Carboniferous system, and the Central Basin soils derived from the massive limestones of Silurian age. Ten types of soil were mapped, including Rough stony land and a very small area of Guthrie silt loam.

The Hagerstown loam is a rich, heavy, brown loam occupying low, rolling hills and gentle valley slopes. It is probably the best soil for general farming in the county.

The Davidson loam is quite similar to the Hagerstown loam, the principal differences being that it has a reddish-brown color and contains a small quantity of sand because of brown sandstone found interbedded with the limestone.

The Hagerstown stony loam is heavier than the Hagerstown loam, contains a large quantity of broken limestone, and occupies steep hillsides. Much of it is used for grazing.

The Clarksville stony loam is a gray to light-yellow or light-brown loam to silty loam, containing a large amount of chert and broken rock. It occupies the tops and steep slopes of rough, broken hills, and is the most extensive soil type in the county. Much of it is still in forest.

The Clarksville silt loam is a gray to light-yellow silt loam found on the broad, level tops of ridges. Only a small part is under cultivation. It is generally regarded as a poor soil. Under proper cultivation, however, it produces excellent truck crops.

The Decatur silt loam is associated with the Clarksville silt loam, the principal difference being that it has a reddish-brown to red color and is a more productive soil.

The Huntington silt loam consists of the bottom lands along Elk River and the larger creeks. It is a very rich, heavy, productive soil, and is cultivated largely to corn.

The Huntington gravelly loam consists of the bottoms along the smaller streams where there has been an accumulation of gravel in the soil.

The Rough stony land consists of areas where there are frequent rock outcrops and bed rock is only a few inches below the surface. These areas are too rough for cultivation. Many of them are covered with a growth of red cedar and are known as Cedar glades.

SOIL SURVEY OF MARION COUNTY, INDIANA.

By W. J. GEIB and FRANK C. SCHROEDER.

DESCRIPTION OF THE AREA.

Marion County is located approximately in the center of the State of Indiana and is bounded on the north by Hamilton and Boone counties, on the west by Hendricks, on the south by Morgan

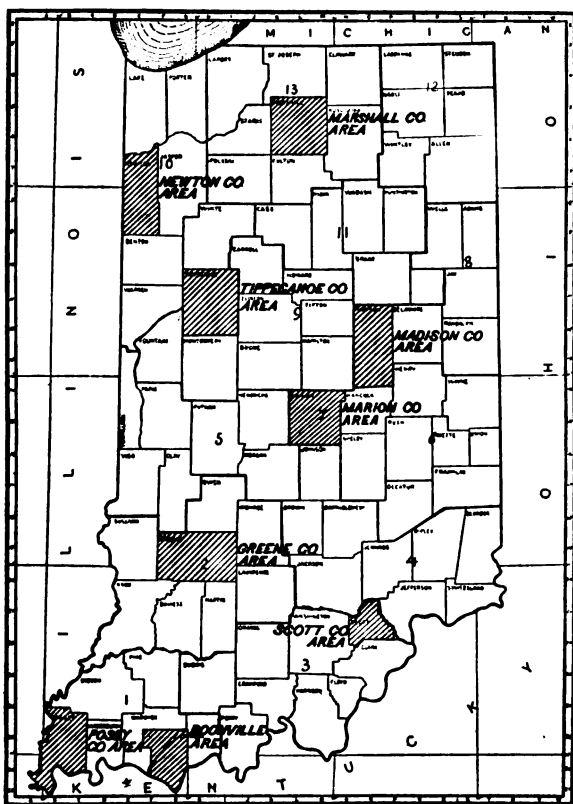


FIG. 26.—Sketch map showing location of the Marion County area, Indiana.

and Johnson, and on the east by Shelby and Hancock counties. It has an area of 248,704 acres, or about 389 square miles.

In topography the surface varies from level to gently rolling or rolling. That portion of the area which lies within the bottoms along White River is level, with only here and there slight undula-

tions, and about one-third of the remainder of the area is also level or undulating. The level stretches in the upland, which vary in size from 1 to 4 or 5 square miles, are surrounded by and gradually grade into gently rolling and rolling lands. The roughest portion is found along Eagle Creek in the northwestern corner of the county. Here a few of the slopes are too steep to be cultivated. Other limited areas of broken land are found at intervals along Eagle and Fall creeks and White River. One very conspicuous hill lies in the southwestern part of the county on the west side of the White River, about $1\frac{1}{2}$ miles from the county line. It can be readily seen for miles, as it reaches an elevation of nearly 100 feet above the surrounding country. Another prominent hill or short ridge lies immediately northeast of Glen Valley.

The average elevation of the county above sea level is 860 feet, and occasionally an elevation of 900 feet is reached. The mean elevation of the land above the valley of White River is 175 feet.

The White River, running in a tortuous course 20° east of north and south of west, divides the county unequally, the western portion being a little more than one-half as large as the eastern, or one-third of the whole area. After crossing Marion County the White River continues in a southwesterly course until it is joined by the East Fork of the White River, and thence it flows into the Wabash River and later into the Ohio.

The drainage of practically the entire county is directly into the White River. Eagle Creek enters the area near the northwest corner, flows southerly, and empties into the White River a few miles below Indianapolis. Fall Creek enters the northeast corner of the county, flows southwest, and empties into the White River within the city limits. Several other smaller streams traverse portions of the county and join the river. Buck Creek, which crosses the southeast corner of the county, flows into the East Fork of the White River.

Throughout those portions of the county where the surface is gently rolling or rolling, or where there are gravel beds within 4 or 5 feet of the surface, the natural drainage is good. Where the surface is level, however, as is frequently the case throughout the uplands and always in the bottoms, the natural drainage is often deficient. There are also numerous small depressions, formerly swamps, in which the natural drainage is poor. Tile drains and open ditches have been employed with marked success where the natural drainage is deficient. Practically all the swamps, none of which were of great extent, have been reclaimed, and the value of these formerly cold and wet lands has been greatly increased.

The first settlement within the limits of the present survey was made on the site of Indianapolis in 1820. Marion County was organ-

ized by act of the legislature in 1821. The central and western portions were settled first, but it was not long until settlers were scattered over the entire area. The early settlers came from Kentucky, Ohio, and Pennsylvania, and a few from Virginia and the Carolinas. At the present time the population throughout the rural districts is evenly distributed.

Indianapolis, the capital of Indiana and the county seat of Marion County, is located in the central part of the area as well as in the center of the State. From the completion of the first railway, in 1847, to the breaking out of the civil war there was a decided quickening of the city's energy and development. More railroads were constructed and business expanded. Railroad building continued with Indianapolis as a center, and the population increased rapidly. The growth of the city has been and still is steady and permanent. The industries of the city have a wide range, and include the manufacture of farm implements, carriages, and farm machinery.

The most important villages are Southport, West Newton, Valley Mills, Bridgeport, Clermont, Broad Ripple, Lawrence, Oaklandon, Cumberland, New Bethel, and Acton.

The transportation facilities for this county and the surrounding country are excellent. Radiating from Indianapolis, like the spokes of a wheel, there are fifteen steam railways and twelve electric lines. So completely do these roads traverse Marion County that no point is more than 4 miles distant from a steam or electric railroad. Within the area there are approximately 175 miles of steam railways and 135 miles of electric lines.

The dirt roads of the county are kept in excellent condition, and owing to the numerous deposits of gravel there is an abundance of excellent road-building material. There are about 350 miles of free gravel roads within the area and more are being improved each year. All toll roads have been abolished.

Indianapolis, with its population of 230,000, affords an excellent market for the products of Marion and the adjoining counties. Large quantities of hay, grain, dairy and poultry products, and vegetables are shipped in from the surrounding country to supply the city markets.

CLIMATE.

There are no marked peculiarities in the climatic conditions of the area. Extreme temperatures seldom occur and the rainfall is well distributed throughout the year. The following table, compiled from the records of the Weather Bureau station at Indianapolis, shows the mean monthly, annual, absolute maximum and minimum temperature, and mean monthly and annual precipitation, as well as

the total amount for the driest and wettest years, and also the average depth of snow:

Normal monthly and annual temperature and precipitation, etc., Indianapolis.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.
January.....	28	60	-25	2.8	1.6	4.9	6.9
February.....	31	72	-18	3.3	1.6	4.6	4.4
March.....	40	82	0	3.8	4.1	7.4	3.6
April.....	52	87	19	3.4	3.2	2.3	1.3
May.....	63	96	31	4.0	2.4	5.1	0.1
June.....	72	100	39	4.4	3.5	7.5	0.0
July.....	76	106	48	4.2	0.8	7.5	0.0
August.....	74	101	46	3.2	3.6	5.9	0.0
September.....	67	98	30	3.3	0.7	3.9	0.0
October.....	55	89	22	2.8	3.5	4.4	Trace.
November.....	42	76	- 5	3.7	1.2	2.3	1.6
December.....	33	68	-15	3.0	4.1	0.9	5.1
Year.....	53	106	-25	41.9	30.3	56.7	22.9

As will be seen from the foregoing table, the average annual precipitation is 41.9 inches. The greatest amount of rainfall occurs in May, June, and July, and the smallest in October and January. The average annual temperature is 53° F.

The following table gives the dates of the last killing frosts in the spring and the first in the fall, for the period of seven years:

Dates of first and last killing frosts.

	Indianapolis.			Indianapolis.	
	Last in spring.	First in fall.		Last in spring.	First in fall.
1899.....	Apr. 9	Sept. 30	1904.....	Apr. 21	Oct. 23
1900.....	Apr. 13	Nov. 6	1906.....	Apr. 23	Oct. 10
1901.....	Apr. 9	Oct. 18	Average.....	Apr. 13	Oct. 24
1902.....	Apr. 8	Nov. 23			
1903.....	Apr. 5	Oct. 24			

It will be seen from this table that the average date of the last killing frost in the spring is April 13, and of the first in the fall is October 24, thus giving a growing season of over six months.

AGRICULTURE.

As stated elsewhere in this report, the first settlement in Marion County was made in 1820, prior to which time little was known of

this immediate locality except the information gained by early hunters and traders. The Indians who occupied this portion of the State before the advent of the white settlers had cleared small patches of ground here and there in the forest, and small quantities of corn were raised.

At this time the entire county was covered with forests of oak, beech, maple, walnut, ash, elm, hickory, and sycamore, and the clearing of fields was a difficult task. The timber, which would now be very valuable, was cut down and burned. The first crop was usually corn, and there was more of this staple grown than any other in the early days. Wheat was also grown, and hay was made from the wild grasses. By 1850 there were in Marion County 82,525 acres of improved land in farms, the cash value of which was \$3,461,545. During this year there were 1,123,860 bushels of corn, 110,334 bushels of wheat, 89,318 bushels of oats, 21,831 bushels of potatoes, and 7,485 tons of hay produced within the county.

The methods of culture followed were somewhat crude. Cultivation was never as thorough as at the present time. The ground was turned with a breaking plow, harrowed once, sometimes not at all, and the seed planted. Though the cultivation was deficient, the soil was new and strong and good yields were obtained. Corn was often grown upon the same field for twenty consecutive years, and the same was true of wheat. Practically no attention was paid to the rotation of crops. The bottoms were recognized as being better adapted to corn, while the uplands were known to be better suited to small grain crops.

Corn, which was the leading staple in early days, is still the first crop of importance. Probably the largest acreage was devoted to corn in 1880, when there were 60,937 acres, which yielded 2,227,537 bushels, or about 37 bushels to the acre. A larger yield was obtained in 1900, when 56,759 acres produced 2,431,640 bushels, or an average of 43 bushels per acre. In 1906 the acreage was 42,845, with an average of 45 bushels per acre. The average for 1905 was 45½ bushels per acre. Yellow corn is grown almost entirely, and it is of good quality. While portions of the area produce as high as 70 bushels per acre, a conservative estimate places the average yield at 40 bushels. Much more care is being taken now than formerly in selecting seed and in cultivating the crop.

The extensive growing of wheat has been continued longer in this part of the country than in many other sections, for the reason that the soil is fairly well adapted to the production of this grain and a comparatively small amount of labor is required. Only winter wheat is grown. In 1880 there were 34,527 acres in wheat, which produced 729,330 bushels, or an average of 21 bushels per acre. In 1900 there were 49,791 acres, which yielded 848,980 bushels, or 18 bushels per

acre. In 1906 there were 27,944 acres, which yielded 707,583 bushels, or 25 bushels per acre. This last was an exceptional yield and the largest in the history of the county. For the years 1903, 1904, and 1905 the averages were, respectively, 13, 11, and 16 bushels per acre. For the entire county 16 bushels per acre is considered an average crop. The acreage of wheat is decreasing, as is also the yield per acre. Continuous cropping of wheat on the same fields has reduced the productivity of the soil until under present conditions wheat growing is not as profitable as formerly.

The acreage of oats in Marion County has always been comparatively low, but it has been on the increase for the last few years. In 1880 there were 6,275 acres, in 1900, 6,071 acres, and in 1906, 15,786 acres devoted to this crop. A yield of 35 to 40 bushels per acre is considered an average for this section.

The soils of the county are well adapted to the production of grasses, and the yields of hay are from 1½ to 2½ tons per acre. Timothy and clover both yield well. These are usually seeded with wheat, there being but little of either sown without a nurse crop. Hungarian and German millet are also grown to a small extent, and a few patches of sorghum were seen. Little attention has been given to alfalfa. A few small fields occur, but do not give satisfactory yields. With careful attention alfalfa could be profitably grown.

Considering the excellent market afforded by Indianapolis, it would seem that more Irish potatoes could be profitably grown in the area. In 1900 there were 2,421 acres in the county, which yielded an average of 73 bushels per acre. In 1905 there were 2,052 acres, with an average yield of 104 bushels per acre, and in 1906 the average was 70 bushels per acre. Within the last few years the growing of tomatoes and peas for canning purposes has received some attention. In 1906 there were 1,230 acres of tomatoes and 1,379 acres of peas in the county. The yield of tomatoes varies from 125 to 225 bushels per acre, and the price paid thus far averages about 22 cents per bushel. An average crop of peas is expected to net about \$40 an acre.

There is but one canning factory in the area, but another is located a few miles south of the county line. These factories contract with the farmers to grow a certain acreage. The factory grades the peas and pays a stated price for each grade. A large percentage of the vines are fed to stock. Substations or branch factories should be established at various points throughout the county.

Strawberries are grown to some extent, and 250 crates of 24 quarts each is considered an average yield per acre. The vines are allowed to bear for two years, when the beds are plowed up. Currants, raspberries, blackberries, cabbage, lettuce, radishes, and other truck crops are also grown, but the trucking industry has never been extensively developed in the vicinity of Indianapolis. Apples, peaches, and pears

are grown only to a limited extent. There are a few pear orchards of commercial size. Almost every farm has a few apple trees and sometimes a few peach trees, but these fruits are not especially adapted to this section. A few grape vines have been planted and do fairly well. It is thought that the grape and pear industry could be profitably extended.

Owing to the large quantity of dairy products consumed in Indianapolis, dairying has developed into an important industry in the surrounding country. A number of farmers make a specialty of dairying, while many others practice general farming and engage in dairying to some extent. Most of the cows are turned out to pasture during the summer. By employing soiling crops much larger herds could be supported upon the same acreage. Comparatively few silos are found in the area. Judicious planting of such crops as oats, peas, millet, corn, and sorghum will provide a continuous supply of good forage until the time of killing frosts in the fall, and sufficient silage for the remainder of the year. There is at present a predominance of Jersey blood in the dairy stock, but there are also many of the so-called dual-purpose cows. It would be more advisable for the dairyman to make a specialty of the dairy breeds.

Approximately 20,000 gallons of milk and 8,000 gallons of cream are delivered daily to patrons in the city of Indianapolis. Only one-sixth of this quantity is produced in Marion County, the remainder being shipped in on the electric and steam roads from the surrounding country for a distance of 50 to 60 miles. The county produced in 1906 719,424 pounds of butter. Much creamery butter is shipped in from various parts of Indiana, Illinois, and Wisconsin. There are only a few creameries within the county.

The number of beef cattle is much less than the number of dairy cattle. There were in the county in 1905-6 about 3,000 head. The number of hogs on hand over 3 months old was 17,337. Only a few sheep are kept at the present time. Taking the statistics of the State agricultural report for 1906 and reckoning the number of horses, cattle, sheep, and swine in the county, it is found that there are approximately 3 acres of improved land for each animal. By more intensive farming the number of live stock should be greatly increased.

There are large stockyards in Indianapolis to which local stockmen can easily deliver their fat stock directly. The nearness of this market tends to encourage the raising of fat stock, as freight charges and commissions are saved. There are several farms in the area which make a specialty of raising horses, mostly racing stock.

In the matter of crop adaptation it has been recognized for many years that the soil along the bottoms of White River and its tributaries is better adapted to corn, and that the upland soils are better

suited to the small grain crops. The closer adaptation of crops to soils has not been worked out. The following rotation is practiced: Corn, oats, wheat, and grass. Hay is usually cut from a field for two years, after which the field may be pastured for one or two years longer.

All the stable manure produced on the farms is applied to the fields, but this supply is insufficient to meet the needs of the soil. Large quantities are also brought from Indianapolis. The manure from the stockyards can be obtained for 25 cents a load. This is very rich and contains but little straw or litter of any kind. Loss is frequently incurred by stacking the manure in the field and allowing it to remain for considerable time. It should be spread upon the field as soon as hauled.

Throughout this county, as in many other sections, the farmers experience some difficulty in securing labor for the farm. To obtain good help the farmer must be willing to pay as much as the factories or other industries of the city. When such wages are paid, sufficient labor can be secured. On the farms \$1.50 a day with board is usually paid for ordinary work, though it is sometimes necessary to pay \$2 a day during harvesting or other busy periods.

Many of the larger farms are being divided into smaller holdings and more intensive methods of cultivation are being followed. The average size of farms in the county in 1900 was 70.6 acres. The census of 1900 states that 48.4 per cent of the farms of the county were operated by the owners. As the average size of farms decreases the proportion of those who operate their own farms increases. The rental price of farm land is high, ranging from \$4 to \$7 an acre, and even as high as \$10 an acre. The highest rent is paid for the trucking land near the city. Only a few farms are rented on shares, but when this system is followed the renter furnishes everything and gives the landowner one-third of the crop, or each may furnish half and divide the crop equally. The cash rental is preferred.

The value of farm lands in the county is constantly increasing. The price ranges from \$75 to \$300. There are few farms for sale in the county for less than \$100 an acre.

Considering the high price of land and the low yields of wheat, the acreage of that crop should be reduced and the land be devoted to more intensive farming. The yields of corn can be increased by careful selection of seed, thorough cultivation, and proper fertilization. A careful study should be made of the needs of the soil, so that fertilizers may be applied intelligently. In Indianapolis it is no uncommon thing for the customer to pay \$1 or more a bushel for Irish potatoes, and the price seldom falls below 50 cents. It can not be too strongly urged on the attention of the farmers of this section that there is a good opportunity for the growing of this crop.

There is also splendid opportunity for the higher development of the dairy industry, since so small a percentage of the dairy products consumed in Indianapolis are produced in Marion County. Milk sells for 7 cents a quart, and the price of creamery butter seldom falls below 30 cents a pound.

SOILS.

Marion County includes three distinct geological formations. The eastern portion of the area is underlain by Carboniferous limestone 60 to 100 feet below the surface. Two miles west of the city of Indianapolis the limestone is underlain by black Genesee shale, which has a thickness of 40 feet. In the extreme southwest corner of the county the Genesee shale is overlain by the Knob sandstone. These rock formations are covered to a depth of from 50 to 100 feet by a deposit of drift which forms the surface of the county and determines the character of soils. This drift is foreign in character and general in distribution. It is not a promiscuous deposit of clay, sand, and water-worn pebbles and boulders like much of the eastern glacial drift. Such materials are found in it, but with nearly as much regularity and order as is usually found in stratified rocks. At the base of the drift formation is usually found a compact lead-colored clay. Occasionally may be found thin deposits of very fine gray or yellow sand. Between the clay and the rock on which it rests is generally interposed a layer of coarse gravel or small siliceous boulders. Sometimes this is wanting and the clay lies directly on the rock. In Marion County this clay bed ranges from 20 to 100 feet in thickness and is very uniform in character throughout, except where the light strata of fine sand occur. Above this is generally found a few feet of coarse sand or fine gravel and on this gravel from 20 to 30 feet of true glacial drift of more promiscuous character. In and upon the drift are a few glacial boulders of granite, gneiss, and trap, which rocks are not found in place nearer than the Lake Superior region, whence they have been carried. In the upper drift are the glacial terraces and beds of gravel from which is obtained the best available material for road construction. The most of it is yellow or orange-colored clay with considerable quantities of sand and lime. The gravel terraces are generally found in a succession of small mounds or ridgelike elevations from 10 to 15 feet above the surrounding country and usually rest on a compact clay.

The lower blue clay represents an earlier glaciation (probably Illinoian) than the overlying softer drift of late Wisconsin Age. The material is fine and very much harder and more compact than the drift forming the present surface. The glacial débris which covers this entire region has been influenced since its deposition by weathering and the action of water until at the present time there are seven distinct though closely related soils within Marion County.

Excluding the Muck these soils represent two series—the Miami and the Huntington. The Miami series, which is by far the more extensive, gives rise in the present survey to five soil types, namely, Miami clay loam, Miami loam, Miami sandy loam, Miami gravelly loam, and Miami black clay loam. The Miami clay loam, the most extensive type in the county, embraces nearly all of the upland soil. It has been formed directly from the unmodified drift and is therefore very uniform in texture. The Miami loam, which is closely related to the clay loam, though coarser in texture and containing a higher percentage of sand and fine gravel, has been formed from drift which has been modified to some extent by the action of water, and much of it occurs as a terrace soil lying between the bottoms and the upland. The Miami sandy loam contains a high percentage of sand and some fine gravel and occurs as low ridges or patches adjoining the bottom land. The Miami gravelly loam also occurs as low ridges or hills. The Miami black clay loam occupies depressions in the upland where swampy conditions formerly prevailed and where large amounts of organic matter have accumulated.

The Miami soils occur throughout Indiana, Ohio, Michigan, Illinois, Wisconsin, Iowa, and Minnesota. They are all of glacial origin, and owing to the fact that the organic matter content is low, they are, with one exception, light in color.

The Huntington series, which comprises the alluvial soils lying along the water courses throughout this region, is represented in the present survey by only one type, the Huntington loam.

The Muck represents accumulations of organic matter in advanced stages of decomposition. Only a very limited amount of Muck was encountered in the area.

The following table gives the names and areas of the several soil types shown in the accompanying map:

Areas of different soils.

Soil.	Acres.	Percent.	Soil.	Acres.	Percent.
Miami clay loam.....	188,672	75.9	Miami sandy loam.....	512	0.2
Huntington loam.....	31,040	12.5	Muck.....	256	.1
Miami loam.....	24,768	10.0			
Miami black clay loam.....	2,880	1.1	Total.....	248,704	
Miami gravelly loam.....	576	.2			

MIAMI CLAY LOAM.

The surface soil of this type consists of a light-brown or ash-gray fine loam or silty loam extending to a depth of 8 to 12 inches. The color varies considerably with the moisture conditions. Immediately after a rain when there is the maximum amount of moisture present the soil is of a brown color, but when the surface becomes dry the soil

is ashen gray, or frequently whitish in color. In the small depressions where organic matter has accumulated the surface is always darker than on the higher places. The texture may vary slightly in different localities, but there is always present a high percentage of silt which imparts to the soil a smooth feel.

The subsoil to a depth of 36 inches consists of a brown, yellow or mottled, stiff, tenacious clay loam. There is frequently present in the subsoil below 24 inches a sufficient amount of angular gravel to impart a slightly gritty feel. This gravel content sometimes increases with depth and the size and proportion of gravel may increase until a gravel bed in a clay matrix is encountered. The gravel is often lacking when the subsoil grades into boulder clay. The areas under which gravel beds may be encountered are small when compared with the extent of the entire type.

Some difficulty is occasionally experienced in securing a good seed-bed, if cultivation is not carried on under proper moisture conditions. Clods sometimes form, and considerable time is required to pulverize them. If plowed when moisture conditions are favorable, however, there is but little difficulty in putting the soil in good tilth.

The Miami clay loam is the most extensive type, occupying nearly 76 per cent of the area of the entire county. The same soil extends for many miles beyond the limits of the present survey. It occurs with remarkable uniformity in different parts of the county, with the exception of such changes as attend the varying drainage conditions in local areas. Occupying the uplands, its elevation is greater than that of any other soil in the area. The White River, which is bordered on both sides throughout most of its course by the Huntington loam and Miami loam, divides the survey into two parts of unequal size. The continuity of the two extensive areas of Miami clay loam is broken only by the bottom land along the small streams and the small areas of Miami black clay loam which occupy the depressions where large amounts of organic matter have accumulated.

The surface of the Miami clay loam varies from level to gently rolling, becoming more rolling and broken along some of the streams. The roughest portions are found in the northwest corner of the county along Eagle Creek and in the northeast corner along Fall Creek. There is a sharp descent from the upland to the streams, and here some of the slopes are too steep to be cultivated. The broken areas are of small extent, however, and the gently rolling surface is again encountered at a distance of from one-fourth to one-half mile from the streams. Between the areas of Miami clay loam and the White River the steep descent found along portions of Fall and Eagle creeks is absent, but there is usually a gradual descent to the bottom lands. Sometimes there is a well-defined terrace where a drop of 8 to 20 feet occurs. The gradation from the Miami clay loam into the Miami loam is frequently so gradual that it is difficult to establish a boundary.

Where the surface of the type is rolling or where there is gravel underneath, the natural drainage is good, but where the surface is level or nearly so, and in the small depressions, the drainage is poor. In these places tile drains and open ditches have been constructed and their use has proved very profitable. The extension of these drains would further increase the value of the land in many instances.

The material from which the Miami clay loam is derived consists of glacial drift which was laid down by the great ice sheet. The depth of the younger glacial drift is usually from 20 to 30 feet, while the depth to the underlying rock is from 50 to 150 feet. A few glacial boulders occur upon the surface, but not in sufficient numbers to interfere with cultivation. These are of granite, gneiss, and trap.

The original timber growth on this type consisted of beech, oak, hickory, maple, elm, ash, and walnut. The entire county was originally covered with timber, but the forests have gradually disappeared until only a few scattered wood lots of 5 to 15 acres are to be seen.

The Miami clay loam is considered a good general farming soil, and such crops as wheat, corn, oats, and hay are grown successfully. In the early days wheat was grown extensively and often on the same field year after year. The acreage of corn is greater now than formerly, though this crop was always extensively produced. Instances were found where fields have been cropped continuously to corn for twenty years. This custom has been greatly improved upon, but even at the present time it can not be said that a systematic crop rotation is practiced upon this type. The most common practice is to have wheat follow corn. Clover and timothy are seeded with the wheat and the meadow is left for two years, after which the field may be pastured for one or two years, when it is planted again to corn. When oats are grown this crop usually follows the corn. Corn and wheat are frequently grown for two years in succession in the same field. It will thus be seen that there is little regularity in the system of cropping.

The yields of wheat vary considerably, but an average for ten years is placed at 16 bushels per acre. Forty bushels is considered an average yield of corn and oats. Hay yields from $1\frac{1}{2}$ to $2\frac{1}{2}$ tons per acre. Irish potatoes do fairly well upon this type and yield an average of 100 bushels per acre. Tomatoes and peas are grown for canning purposes, and the acreage is increasing. Tomatoes yield 200 bushels per acre and an average price for the last few years has been 22 cents a bushel. Forty dollars is considered a fair average net return from an acre of peas.

Near Indianapolis some trucking is carried on, and this industry could be profitably extended. Strawberries do very well; also currants and raspberries. Grapes, though not grown to any extent,

could be profitably produced on a commercial scale. The acreage of wheat should be reduced and a more intensive system of agriculture practiced. A greater number of live stock should be kept and there is a good opportunity for the extension of the dairy industry.

All the stable manure produced on the farm is used upon the fields and considerable amounts are brought from the city. Commercial fertilizers are also used, and their use is considered profitable.

Farms in the Miami clay loam range in value from \$75 to \$250 an acre, depending on the location.

The following table shows the average results of the mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Miami clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17620, 17624.....	Soil.....	1.1	6.6	3.9	13.9	9.2	50.6	14.1
17621, 17625.....	Subsoil.....	.5	5.1	4.3	14.4	10.3	44.4	20.4

MIAMI LOAM.

The surface soil of the Miami loam consists of a mellow brown loam of medium to fine texture extending to an average depth of 12 inches. There is frequently present on the surface and mixed with the soil a small amount of gravel, but this is never sufficient to interfere with cultivation or to affect the agricultural value. The subsoil to 36 inches consists of a heavy loam or light clay loam which contains sufficient fine, angular gravel to make it decidedly gritty. The gravel content usually increases with depth, and a bed of gravel is sometimes encountered at 3 to 4 feet. Small ridges of gravelly loam occur at intervals and where these are of sufficient size they have been indicated on the map. On the slopes between this type and the Huntington loam there is often found a narrow band of gravel, but it is usually too small to be indicated.

The Miami loam differs from the Miami clay loam in that the surface is darker in color and coarser in texture. There is much less silt present in the surface soil; the subsoil contains a much larger percentage of fine gravel than the Miami clay loam, which makes the natural drainage conditions somewhat better. The Miami loam is easy to cultivate and a mellow seed bed can be secured more readily than on the clay loam.

The Miami loam is frequently spoken of as second bottom land, and throughout a portion of its extent it appears as a terrace soil between the Huntington loam and the Miami clay loam. The largest area lies directly west of Indianapolis, between White River and

Eagle Creek, and extends south on the west side of Eagle Creek to 2 miles below Maywood. Another area of considerable size lies between Lick Creek and the south county line bordering the bottom land along the river. Other areas of smaller extent occur along the White River to the north of Indianapolis and along Fall and Eagle creeks.

The surface varies from level to gently rolling. Where level, as is more often the case, the areas of this soil have the appearance of being a broad terrace. The boundary between this and the Huntington loam, or first bottom, is often very distinct, there being a sharp descent of 5 to 20 feet, with a distance of a few rods. The boundary between the Miami loam and the clay loam, however, is not so marked. There is occasionally a sharp rise, but it is more often a gradual slope, so that the two soils grade into each other, making it difficult to establish a dividing line. Where the surface is gently rolling the appearance is practically the same as the surface of the clay loam, and there is no suggestion of its being a terrace or second bottom.

Owing to the gravel present in the subsoil, the natural drainage is good. Over portions of the type, however, where the surface is level tile drains greatly improve the physical condition and the productivity of the soil. The Miami loam has been derived from the glacial drift which covers the region. The presence of beds of water-worn gravel at depths of from 3 to 5 feet indicates that portions of the type at least have been influenced by the action of water to a greater extent than the Miami clay loam, in which the gravel is more angular.

The Miami loam is a good general farming soil and produces fair yields of wheat, oats, corn, and hay. The system of cropping is the same as on the Miami clay loam, no definite crop rotation being followed from year to year. Potatoes, tomatoes, and peas are also grown, and the trucking industry has been developed to a greater extent than on any of the other soils of the county.

Wheat yields an average of 15 bushels per acre, corn 45 bushels, oats 45 bushels, and hay from 1½ to 2 tons per acre. Corn and oats seem to do a little better on this soil than on the heavier type, but all things being considered they are of about the same value for general farm crops. The loam is better adapted to truck crops than the clay loam and it should be devoted more extensively to this industry, as much greater returns per acre could be secured than are now obtained by general farming. Stable manure is used extensively and commercial fertilizers are also applied to this soil.

Farms on this type of soil range in value from \$100 to \$300 an acre.

The following table shows the average results of the mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Miami loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17614, 17616.....	Soil.....	1.3	9.1	11.6	16.5	8.3	39.9	13.3
17615, 17617.....	Subsoil.....	2.3	12.9	12.7	11.4	5.5	41.5	14.1

HUNTINGTON LOAM.

The surface soil of the Huntington loam to a depth of 10 to 16 inches consists of a mellow, brown to dark-brown loam of medium to fine texture. There is usually sufficient silt present to impart a smooth feel to the soil. In small depressions and for a short distance back from some of the streams the soil is often nearly black in color, owing to the excess of organic matter accumulated in these places.

The gradation from soil to subsoil takes place gradually, and frequently there is little change to a depth of 20 inches. The subsoil becomes slightly heavier with increased depth until at 24 inches it is a heavy loam. The color is a dark brown, usually becoming lighter with depth. The subsoil contains considerable silt to a depth of 36 inches, where a bed of sand is sometimes encountered. Lenses of sand are scattered throughout the type, but these are not of sufficient size to be indicated in the map. This type is comparatively easy to cultivate, and a mellow seed bed is readily secured.

The Huntington loam occurs as first bottom along the White River and all of the smaller streams within the survey. The most extensive area lies along White River from Indianapolis south to the county line. Throughout this distance it varies in width from 1 to 2 miles. The type continues north of the city, but is scarcely ever more than one-half mile in width. The bottoms along Eagle and Fall creeks are also of this type, and there is a narrow strip along practically all of the smaller streams within the county. The soil in these smaller bottoms is frequently influenced by the wash from the higher lands, and therefore there are some differences in this soil and the soil in the more extensive bottoms. This variation, however, is never of sufficient importance to warrant the establishing of a new type.

The Huntington loam is an alluvial soil, being composed of glacial material which has been reworked and redeposited by the action of the streams, along which it is now found. The surface is level, with only here and there slight undulations and small depressions. Owing to this topography and the low-lying position the natural drainage is

poor. The soil lying close to the river is frequently overflowed, and as a result crops are damaged. Levees have been constructed in some places, and these now keep the river within its banks for a portion of its course. Tile drains and open ditches have been constructed, and at present almost the entire type is under cultivation. When the river overflows a sediment is left upon the surface, which is very beneficial to the soil.

The original timber growth on this soil consisted of ash, elm, and sycamore, with some hickory, oak, and beech. The land is used for general farming, although corn is grown more extensively than any other crop and is better adapted to the soil than grass or grain crops. While wheat and oats are grown to some extent the grain often lodges badly and does not properly mature. Hay makes a rank growth and may also lodge before it matures.

On that portion of the type subject to overflow the yield of corn is about 70 bushels per acre, while on that not overflowed 50 bushels is considered a good average crop. This difference is due to the sediment deposited, which proves to be a very valuable fertilizer. Oats average 40 bushels and hay from 1½ to 2 tons per acre.

Stable manure is used to some extent on a portion of this soil which is not overflowed, but commercial fertilizers only sparingly. Upon some of the areas near the city trucking is followed with good results. Tomatoes, peas, lettuce, cabbage, onions, radishes, strawberries, and potatoes are grown with profit. This industry should be extended.

Farms range in value from \$125 to \$400 an acre, depending on the location.

The following table gives the results of mechanical analyses of samples of soil and subsoil of this type:

Mechanical analyses of Huntington loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17626.....	Soil.....	0.0	0.8	1.1	13.0	31.1	44.2	9.0
17627.....	Subsoil.....	.6	1.8	1.0	16.4	22.2	48.4	9.6

MIAMI BLACK CLAY LOAM.

The soil of the Miami black clay loam consists of a heavy, black loam or light clay loam extending to an average depth of 14 inches. The depth varies somewhat, being greater in the center of an area than near the outer margin. The soil contains a high percentage of organic matter, and to this may be attributed the black color. With increased depth the color becomes lighter. The soil is cohesive, with a tendency to puddle, and if cultivated too wet large clods are formed

which are difficult to pulverize. On drying, cracks an inch wide and a foot deep are often formed on the surface. If cultivated at the proper time little difficulty is experienced in securing a good seed bed. The soil gradually becomes heavier with increased depth; below 14 to 16 inches it grades into a clay loam of drab or grayish color, and at 24 to 30 inches it may have a yellowish or mottled appearance.

The Miami black clay loam occupies only a small percentage of the area surveyed. It occurs in small basinlike depressions throughout the upland, and is occasionally found along some of the smaller streams. These bodies vary in size from 5 to 160 acres. They are most numerous in the southern part of the county in the vicinity of Southport, but small patches may be encountered in any part of the survey.

The material composing the Miami black clay loam is of glacial origin, but since its deposition it has been modified to considerable extent. Prior to the construction of drainage systems sufficient to carry off the surplus water these small areas were covered with swamps and marshes. Through the growth and decay of vegetation large amounts of organic matter have been added to the soil, the rapid oxidation of which was prevented by the excessive moisture. Some of the finer particles of soil have been washed into these depressions from the surrounding higher land, and this has had considerable influence on the texture of this soil.

Though of limited occurrence, the Miami black clay loam is a very good soil, especially for the production of corn. When well drained and under favorable climatic conditions it produces 50 bushels per acre. Although there is danger of lodging, the average yield of oats is estimated at from 35 to 40 bushels per acre. It is also well adapted to clover and timothy, the latter yielding from 1 to 2 tons per acre. Only the best drained areas are suited to clover, because in the wet places the soil heaves badly and the plants are killed.

The following table gives the results of mechanical analyses of the soil and the subsoil of this type:

Mechanical analyses of Miami black clay loam.

Number	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17618.....	Soil.....	0.2	3.1	3.7	12.5	12.5	56.3	12.1
17619.....	Subsoil.....	.0	2.1	2.7	11.8	10.5	56.0	17.6

MIAMI GRAVELLY LOAM.

The surface soil of this type consists of a heavy brown sandy loam or loam of medium texture extending to an average depth of 12 inches. There is present on the surface and mixed with the soil

from 10 to 20 per cent of gravel usually less than one-half inch in diameter. The subsoil is a brownish, light clay loam usually containing a higher percentage of gravel than the soil, and frequently grading into a bed of gravel at 2 to 4 feet.

The soil is of small extent. The largest area is found in the extreme southern portion of the county just northeast of Glen Valley. Here the soil occurs as a ridge 40 to 50 feet higher than the surrounding country, and extends for $1\frac{1}{2}$ miles from northwest to southeast. Another gravel hill of considerable size lies adjacent to the west side of the White River, one-half mile north of the south county line. Other small bodies are scattered about the county, but most of them are found near White River or one of its tributaries. These small divisions occur as low, narrow ridges or nearly level areas. The largest area somewhat resembles a moraine. The entire type is of glacial material, portions of which have been influenced by the action of water.

The greater proportion of the type is under cultivation and, while it frequently suffers from drought, fair yields are obtained. The crops grown are the general farm crops, corn, oats, wheat, and grass, which are common to this section of the country.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Miami gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17610.....	Soil.....	3.4	16.1	14.0	8.5	7.8	39.6	11.4
17611.....	Subsoil.....	6.4	9.3	18.1	9.3	3.9	21.5	31.9

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17610, 2.41 per cent; No. 17611, 8.80 per cent.

MIAMI SANDY LOAM.

The surface soil of this type, to an average depth of 10 inches, consists of a light, brownish sandy loam of medium texture. There is present on the surface and mixed with the soil a small amount of fine gravel. The subsoil is a light-brown or yellowish loamy sand of medium to coarse texture, containing varying amounts of fine gravel and frequently grading into a gravel bed at 3 feet.

This type is of very small extent, occupying only about 1 square mile. Four small patches, which constitute the greater part of the Miami sandy loam, are found about 7 miles southwest of Indianapolis, lying adjacent to the bottom land along White River. There are a few small areas scattered about the county, but all are of little importance. The usual occurrence of this soil is in the form of low ridges, knolls, and small terraces. The material is derived from

glacial débris, much of which has been modified to some extent by the action of water.

The natural drainage is excellent and the type is somewhat drougthy at times. At present the soil is used for general farming, but as it is earlier and more easily worked than the other soils of the county, it should be devoted to the trucking industry. The yields obtained are slightly below those from the heavier soils.

The following table gives the results of mechanical analyses of samples of the soil and subsoil:

Mechanical analyses of Miami sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17612.....	Soil.....	4.3	34.2	19.4	19.0	2.4	13.6	6.5
17613.....	Subsoil.....	3.7	34.4	21.6	18.0	2.6	12.9	5.8

MUCK.

Only two areas of Muck were mapped in the survey of Marion County, and these are of very limited extent. The material consists of vegetable matter in advanced stages of decomposition. Fine earth from the higher surrounding land has been mixed with this type. In color the Muck is black and extends to a depth of 18 inches to 4 or 5 feet, usually resting upon a bed of clay.

One of the areas lies 5 miles due west of Southport, while the other is about the same distance northwest. The former is now in a condition of swamp, but could be easily drained; the latter is cleared, drained, and under cultivation. Corn and grass are grown, but the type is better adapted to celery, and as there is an excellent market for this vegetable in Indianapolis the soil should be entirely devoted to its production.

SUMMARY.

Marion County lies in the central part of Indiana and comprises an area of approximately 389 square miles. The surface varies from level to gently rolling, becoming broken near some of the streams, especially in the northwestern part along Eagle Creek and in the northeastern part along Fall Creek. The average elevation above sea level is 860 feet.

The first settlement in the area was made in 1820. Indianapolis, population 230,000, the capital of the State and the county seat of Marion County, is located in the center of the area. Fifteen steam and 12 electric railways enter the city. There are over 350 miles of free gravel road within the county. All toll roads have been abolished.

The climate does not differ materially from that of other Middle States in the same latitude. Extremes of temperature seldom occur and the rainfall of 41.9 inches is well distributed throughout the year.

Corn is the principal crop. The average yield for the county is 40 bushels per acre. The soils are well adapted to wheat, but continuous cropping has reduced the yield, the average yield being 16 bushels per acre. The acreage is also decreasing at the present time. The acreage of oats has always been comparatively small, but it is increasing slowly. Irish potatoes do fairly well and yield an average of 90 bushels per acre. All trucking crops suited to this climate do well, although the trucking industry has not been extensively developed. Considering the excellent market afforded by Indianapolis, there is a good opportunity for the truck farmer.

Dairying is not followed as extensively as would be expected near a large city. Approximately 20,000 gallons of milk and 8,000 gallons of cream are consumed by the city daily, and of this only about one-sixth is produced within Marion County. There is a fine opportunity for the extension of the dairying industry.

In 1900 the average size of farms was 70.6 acres, and at the same time 48 per cent of the farms were operated by their owners. The size of farms is decreasing, while the proportion of farms being worked by the owner is increasing.

The soils of the area belong to the Miami and Huntington series. The Miami soils have been derived from the glacial material which covers this entire region to a depth of from 50 to 150 feet. The Huntington soils are alluvial in origin. Seven types including Muck were mapped.

The Miami clay loam, the most extensive soil in the county, occupies about 76 per cent of the area surveyed. The surface is level or gently rolling, except near some of the streams, where it is broken. It is considered a good general farming soil, and farms upon this type vary in value from \$75 to \$250 an acre.

The Miami loam is also a good general farming soil and somewhat better adapted to truck crops than the Miami clay loam. Farms on this type range in value from \$100 to \$300 an acre.

The Huntington loam occurs as an alluvial soil along the White River and its tributaries. It is especially adapted to corn and frequently produces 70 bushels per acre. Portions of it are subject to overflow. It has practically the same value as the Miami loam.

The Miami black clay loam occupies the depressions in the upland. It contains a very high percentage of organic matter and is very productive. It produces an average of 50 bushels of corn per acre.

The Miami sandy loam and Miami gravelly loam are types of very small extent and little consequence.

The Muck comprises two areas of decaying vegetable mold in advanced stages of decomposition. Both areas are small and of little importance.

SOIL SURVEY OF THE NORTH PLATTE AREA, NEBRASKA.

By E. L. WORTHEN and O. L. ECKMAN.

DESCRIPTION OF THE AREA.

The North Platte area is situated in Lincoln County, Nebr. In shape it is a rectangle 26 miles long east and west and 18 miles north and south, having an area of about 470 square miles. It includes a little more than the south half of the North Platte quadrangle. It extends from the town of Hershey on the west to the town of Maxwell on the east, and $8\frac{1}{2}$ miles north and $9\frac{1}{2}$ miles south of the town of North Platte.

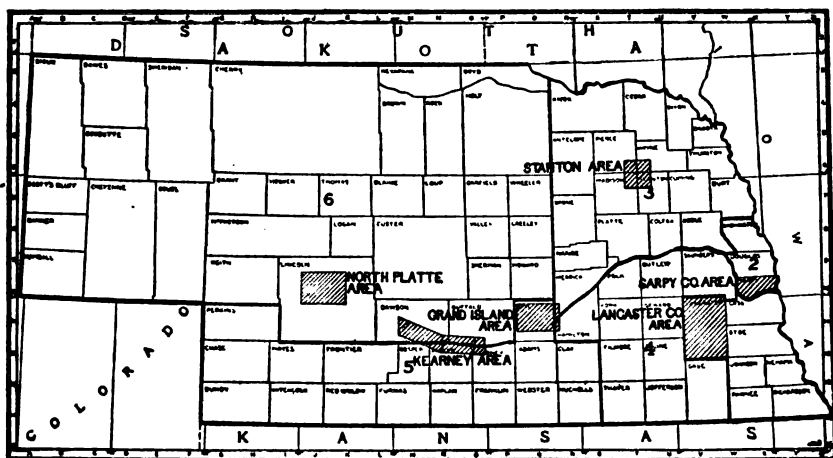


FIG. 27.—Sketch map showing location of the North Platte area, Nebraska.

North Platte, situated in the broad, level valley, has an elevation of 2,800 feet, and the upland is 200 to 400 feet higher. The sand-hills on the north are typical of this section, and many of them are 200 feet high. On the south side of the valley the surface of the upland is generally very rough, being cut by deep canyonlike gorges 50 to 300 feet or more in depth. In the eastern part of the area the bluffs rise abruptly to a height of 350 feet; the crest of the bluff becomes lower toward the west and in the extreme western part of the area there is a gradual slope from the edge of the valley to the

upland. Limestone is found outcropping in places along the edge of the bluff. In the southern part of the area the sandhills are much the same as those to the north except that they are not quite so rough.

The North and South Platte rivers drain the valley to the east. The fall is about 8 feet per mile. About 2 miles east of North Platte the rivers unite, forming the Platte River. There is considerable swampy land in the valley, which on the south is drained into the river through Beer and Fremont sloughs. The sandhills, because of their porous nature, absorb most of the rain. Whitehorse Creek on the north carries most of the underground water from the hills into the North Platte River. The loess is broken by canyons which are dry except during wet spells in the spring.

The country was settled by homesteaders who came from the adjoining eastern States, especially from Missouri. One of the first parties came from Michigan in 1871, but after 1880 there began a steady influx of settlers. The country, however, is now thinly settled, especially in the hills. North Platte, the principal town of the area, has a population of about 5,000 and is located near the center of the area. Hershey on the west and Maxwell on the east each have a population of nearly 200. A substation of the Nebraska Agricultural Experiment Station is located about 3 miles south of North Platte.

The trunk line of the Union Pacific Railroad, which passes through Maxwell, North Platte, and Hershey, furnishes very good transportation facilities. A survey for a proposed line of the Burlington route, which will pass through North Platte, has been made. The country roads are good.

North Platte affords a good local market for fruit, vegetables, and dairy and poultry products; in fact, the demand for these commodities exceeds the supply. Most of the cattle are not fattened here, but are shipped to Omaha, which is the chief live-stock market, where they are sold as feeders. Considerable quantities of hay are shipped to Omaha and Denver.

CLIMATE.

The climate of the area is characteristic of western Nebraska, the temperature for the year averaging about 48° F. December, January, and February have an average temperature of 25° F. The winters are dry; consequently the cold is not felt severely. July and August have an average temperature of 73° F. Although the days are warm, the nights are always cool and there is an almost continual breeze, due mainly to the fact that the country is so open. There is a great deal of sunshine, two hundred days of the year being clear.

The heaviest rainfall is in the growing season, April, May, June, July, and August, mostly in showers from 0.08 to 0.25 inch, so the

greater part of the rainwater is absorbed by the soil. Generally there are only one or two rains in a season when the precipitation is more than an inch. Hail is common but not often injurious.

The following table, compiled from the records of the Weather Bureau station at North Platte, gives the more important data relating to the climatic conditions of the area.

Mean monthly and annual temperature and precipitation, the absolute maximum and minimum temperature, the total precipitation for the wettest and driest years, and the depth of snow at North Platte, Nebr.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maxi- mum.	Absolute mini- mum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.
January.....	24	70	-35	0.4	0.3	1.2	3.5
February.....	25	74	-35	.4	.3	1.4	6.0
March.....	35	86	-21	.8	1.7	.5	6.0
April.....	49	93	12	2.1	1.6	3.1	.0
May.....	59	97	25	2.8	.4	4.1	.0
June.....	68	102	33	3.2	3.5	7.5	.0
July.....	74	107	41	2.6	2.4	1.3	.0
August.....	72	103	40	2.3	.2	4.5	.0
September.....	63	101	21	1.4	.1	1.1	.0
October.....	50	90	9	1.0	.6	3.5	1.8
November.....	35	81	-25	.4	Trace.	.4	2.2
December.....	27	70	-30	.5	Trace.	1.4	2.7
Year.....	48	107	-35	17.9	11.1	30.0	22.2

The average date of last killing frost in spring is May 9, and of the first in the fall September 20, which gives a growing season of about 133 days.

AGRICULTURE.

The agriculture of this section began to make rapid development between 1880 and 1885. In 1880 there were in Lincoln County 47,838 acres in farms, of which 37,660 acres were improved. In 1890 the total acreage in farms had increased to 343,108 acres, of which 204,411 were improved. In the next ten years 258,885 acres more were put into farms. In 1890 the value of farms and buildings was nearly seven times what it was in 1880, or \$3,259,330 as against \$469,403. From 1890 to 1900 the value of farms and buildings increased 20 per cent, and since the last census there has been a steady increment in value.

Irrigation started with the completion of the North Platte Canal in 1884. This was one of the first irrigation canals constructed in the State. Most of the other ditches were dug in the years 1894, 1895, and 1896.

The early agriculture consisted almost wholly of stock raising. For years the uplands were broad, unfenced ranges where the cattle grazed at will. As the land was taken up by homesteaders it became divided into tracts of 160 acres or more. Houses were built and crops planted. Wheat was one of the principal crops of the early settlers; corn, however, has always been the leading cultivated crop. The live stock was of very poor quality during the early agriculture of the area.

With the completion of the irrigation ditches and the separation of the land into small farms or ranches, the agriculture changed noticeably. Stock raising has remained the leading industry, wheat has been grown less extensively in comparison with other crops, the area planted to corn has increased, while alfalfa, sugar beets, and brome grass have been introduced.

Spring wheat was grown rather extensively for a while, but experience has shown that it is not as productive as the winter varieties, and consequently its cultivation has nearly ceased. Alfalfa was introduced about 1898 and has proved a very valuable and successful crop on the soils that are adapted to it. Sugar beets have been grown quite extensively for the last five or six years until the present season. With the closing of the sugar factory at Ames there is no market for this crop nearer than Grand Island, and few farmers consider it profitable to ship beets this distance. This industry will undoubtedly be taken up again as soon as a suitable market is available. Sorghum, kafir corn, and millet are grown for forage, and a limited acreage of barley, rye, and emmer (speltz) is planted. Irish potatoes were grown quite extensively for a number of years on the North Platte loam and for a time gave good results, but gradually the yield became less and for the last few years they have been produced only for home consumption. Much of the valley is still in meadow, its position is low, and poor drainage renders cultivation impossible.

Modern farm machinery is in general use in this area. The one object always kept in mind in the management of farms is the saving of labor. It is the common practice to use four horses in plowing and cultivating, the gang plow and the two-row cultivator being commonly used. Six horses are often hitched to one harrow. Modern harvesting machinery is used in gathering the grain, while the most perfected labor-saving implements are employed in the hay fields. In 1900 the farm machinery of the county was valued at \$228,200.

The live stock is of good quality, especially that found on the ranches in the Platte River Valley. Some blooded cattle and hogs are bred. There are also many fine horses and some mules raised in the area. The value of the live stock in Lincoln County in 1900 was \$1,929,551.

The farmers have in a general way adapted the crops to the different soils, but have paid practically no attention to crop rotation.

The sandy uplands have generally been left as ranges, although occasional attempts have been made to cultivate them, with the result that the land has been injured by wind erosion except in the heavier depressions. Alfalfa is usually sown on soil well suited to its growth. There have been occasional failures on land too poorly drained for this crop or where alkali has accumulated in large enough amounts to be injurious. Manure is thrown away rather than applied to the crops, while straw and cornstalks are commonly burned. With the exception of these general wasteful methods, and the lack of care given to the farm machinery, the agricultural methods are well adapted to the present conditions.

During the harvesting season \$2 to \$2.50 a day is not an uncommon wage for farm hands. Farm laborers when hired by the month receive about \$25 to \$30 and board.

Most of the farms in the valley range from 160 acres to one section in size. Larger tracts are occasionally held by one individual. The sandy uplands are generally owned in tracts of from 1 to 5 square miles in extent. It is of interest to note that the average size of the farms of the county decreased from 402 to 267 acres between 1880 and 1890, at which time the valley was being put under cultivation and the large cattle ranches were separated into smaller farms. Much of the broad, open range on the upland was divided into rather large cattle ranches between the years of 1890 and 1900, thus increasing the average size of the farms of the county to 412.9 acres in 1900.

Possibly half of the farms in the valley are operated by their owners. In 1900, 54.2 per cent of the farms of the county were rented. Where rented, either the cash or share system is followed, generally the former, since the greater part of the land is utilized for grazing or hay production. Practically all the sandy upland is either used as grazing land or else left as open range. It is impossible to rent this character of land at present. Where the valley land is rented for a share of the grain, the tenant usually gives one-third of the crop. The better valley land, adapted to corn, alfalfa, and sugar beets, rents for \$3 to \$5 an acre.

The value of the farm land of the area varies considerably. The valley may be divided into farming land and hay or grazing land. The former is valued at \$15 to \$30, the latter at \$35 to \$70 an acre. The upland north of the valley sells for \$1.50 to \$4 an acre. The south upland varies in value, the sand hills selling for \$2 to \$5, the hilly lands for \$8 to \$12, while the level table-land brings \$25 to \$40 an acre.

The farmers are generally thrifty and show intelligence in their farm work. Better cultural methods could frequently be employed. All cultivation should have for its main object the conservation of

moisture. Shallow and frequent stirring of the soil in order to maintain a good mulch, so that the evaporation of the soil moisture will be kept at a minimum, is to be recommended especially where irrigation is not practiced, and even in the case of irrigated lands the lessening of surface evaporation is very essential in preventing the accumulation of alkali in the surface soil. A more systematic rotation could well be employed on many of the farms. There is also a chance for the further and better adaptation of crops to the different soil types. Practically no valuation is placed on barnyard manure at the present time. The common practice of using it to fill up ditches and mudholes along the roads should cease and the manure should be placed on the fields. The soil should receive more careful treatment and greater care should be employed to maintain its productivity. Any of the soils in the area will deteriorate with constant cropping, especially where the same crop is grown year after year.

SOILS.

The soils of the area are naturally divided into two distinct groups, those occupying the upland on the east side of the Platte Valley, and those situated in the valley itself. These two groups not only differ in having soils of widely different character, but the types are of a distinctly different derivation and age.

The upland north of the river is made up of sand dunes and forms part of that vast area of the State known as the sand-hill district. These sand hills reach an elevation of nearly 3,200 feet at the northern edge of the survey, while the individual dunes have a height of 200 feet or more. The greater part of this sand owes its origin to the Arikaree formation. This is a division of the later Tertiary following the White River group. During this period large quantities of debris were washed down from the mountains and deposited to the eastward, forming a rather flat, sandy, alluvial fan. Later the streams are supposed to have deposited a thin mantle of sands of the Ogalalla formation of the late Pliocene epoch.^a These sand hills are of recent origin and have been formed by aeolian agencies. The sand hills south of the river are of similar formation; they are not, however, of as rough a topography and they have apparently been influenced somewhat by the loess which borders them on the north.

The loess, which occupies the south bluff of the valley, is of Quaternary formation. It is the continuation of the great loess sheet covering the eastern section of the State. In the east part of the area, south of the town of Maxwell, this loess is of great thickness, apparently reaching the depth of 200 to 300 feet or more. To the west it becomes thinner,

^a N. H. Darton, Professional Papers No. 17, U. S. Geological Survey, 1903.

the Ogalalla limestone underlying it being exposed in large areas south of the town of North Platte. From this point west the loess forms a rather thin sheet along the crest of the bluff and extends only 2 or 3 miles, where it gives way to the sand-hill formation which probably overlaps the loess for some distance. The origin of this loess formation is undoubtedly associated with the action of the Platte River. It has been formed subsequently to the glaciation of the eastern section of the State, and owes its origin very probably to an old deposit of the Platte River which has been influenced by aeolian forces. Generally this loess is badly eroded, being cut by numerous canyonlike ravines 100 to 300 feet deep, but there are a few rather level areas. The surface soil in the latter areas contains much more organic matter and is of a slightly more silty nature, while the sub-soil carries considerable clay in the lower areas.

The Ogalalla formation which is exposed above the loess gives rise to small patches of Rough stony land. These areas are of a very stony and somewhat argillaceous nature, though considerable loess is mixed with the surface.

The soils of the valley are of recent alluvial formation and are underlain at varying depths by river sands and gravels. Just below the bluffs occupying both sides of the valley is found soil which has washed from the uplands. Along the south side this deposit has a width of one-half to $1\frac{1}{2}$ miles and closely resembles loess, while on the north edge of the valley it is much more sandy and seldom over one-half to three-quarters of a mile wide. Bordering this is generally found a strip of silt loam from a quarter to 1 mile in width. This silt appears to have been deposited in old channels where the current was very slow. This deposit varies from 2 to 5 feet in thickness and is directly underlain by river sands and gravels. The lower swampy areas of this type have a large amount of partly decomposed vegetable matter mixed with the surface foot and give rise to areas of Muck. Between this silt and the river, and occupying nearly the same level, is a loamy soil 12 to 24 inches deep, underlain by sand and gravel. This soil has been deposited in a more rapidly moving current. The higher portions of the valley proper, which may be considered second bottom, form the oldest of the alluvial formations, and consist either of a loam soil with a heavy sandy clay subsoil, or a soil having the texture of a sandy loam or loamy sand throughout the profile. The latter soil, where immediately adjoining the rivers, frequently owes its origin to the sand blowing from the river beds during dry seasons.

There is some alkali found in the valley soils. Generally where it has accumulated in sufficient quantity to be injurious to crops it is only found in small areas.

Twelve types of soil were mapped in the North Platte area. The name and extent of each type are given in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Dunesand.....	140,352	46.7	Laurel sandy loam.....	10,048	3.3
Finney fine sandy loam.....	40,128	13.3	Gannett fine sand.....	8,448	2.8
Laurel loam.....	24,768	8.2	Riverwash.....	4,672	1.6
North Platte loam.....	23,936	8.0	Muck.....	3,264	1.1
Laurel gravelly loam.....	16,448	5.5	Rough stony land.....	1,344	.4
Osgood fine sandy loam.....	16,320	5.4	Total.....	300,736	.....
Finney loam.....	11,008	3.7			

FINNEY FINE SANDY LOAM.

The soil of the Finney fine sandy loam, to a depth of 6 to 10 inches, consists of a very light-brown to a gray very fine sandy loam. The subsoil is of practically the same texture and differs from the surface in that the humus content is less. In the more broken areas even this difference is hardly apparent. Because of this similarity there is no marked dividing line between the surface soil and subsoil. Throughout the profile this soil consists of a loesslike fine sandy loam with a characteristic silty feel so common to much of the loess along the rivers of the Central States.

This type of soil extends through the area from east to west, occupying the crest of the south bluff of the Platte Valley, and having an average width of 3 to 4 miles. It gradually widens toward the east and at the same time becomes of a finer texture, frequently merging into a silt loam at the eastern border of the area. To the southward it merges gradually into the Dunesand, where naturally the type becomes very sandy.

The area occupied by this type presents a very rough and broken topography. In the western section of the survey the bluff slopes rather gently toward the valley, but it becomes gradually steeper and more rugged to the east, where it rises very abruptly to a height of over 300 feet. The type is, as a rule, too rough and broken to be put in cultivation. The loose, porous structure of this type allows the water to pass readily down through it, but at the same time it is very susceptible to erosion.

The Finney fine sandy loam has been formed from the loess deposit, which varies considerably in depth, being perhaps 10 to 30 feet deep in the western half of the area, and increasing apparently to 200 to 300 or more feet near the eastern border. In many places along the bluff south and southwest of North Platte the underlying limestone is exposed, but in the eastern section, where the ravines have cut down as deep as 350 feet, there is no rock to be seen.

The Finney fine sandy loam is naturally prairie and is covered with a good growth of wild grass, except on the very steep slopes, where the vegetation becomes so scanty that there frequently is hardly enough to hold the soil in place. Very little of the type can be put under cultivation. The more level areas are sometimes cultivated, but on account of the porous subsoil and the small amount of humus in the surface soil the crops are easily affected by drought. This droughty nature of the soil, together with the light rainfall of this district, makes it advisable to utilize this soil type mainly as pasture, though fair crops of corn and wheat can be produced on the more level areas in a very favorable year. It is primarily a type adapted to grazing, and this seems the best means of utilizing it at the present time. It is valued at from \$5 to \$15 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Finney fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16820, 17763.....	Soil.....	0.1	0.3	0.3	10.0	48.6	35.1	5.5
16821, 17764.....	Subsoil.....	.1	.1	.1	4.7	62.0	27.5	6.0

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17763, 3 per cent; No. 17764, 3.86 per cent; No. 16820, 2.32 per cent; No. 16821, 3.95 per cent.

FINNEY LOAM.

The surface soil of the Finney loam is a brown loam to very fine sandy loam with an average depth of about 14 inches. The subsoil is a grayish-yellow to chocolate-colored heavy silty loam or light clay loam. In most cases the texture of this subsoil becomes lighter below 24 or 30 inches, the heavy stratum having a thickness of only 12 to 18 inches. On the table-lands between the canyons in the eastern part of the area this clayey stratum is almost entirely absent. Throughout the profile this type contains larger quantities of fine and very fine sand than is generally the case in types derived from the loess in the eastern part of the State. It differs from the Finney fine sandy loam in that it has a deeper and a darker brown surface soil, which contains much more humus and is generally of a finer texture, while the subsoil runs much heavier in most cases than that of the fine sandy loam. It is commonly referred to as "hard land" in this section of the State.

The Finney loam is confined to the south and southeast sections of the area, occupying the level to gently rolling parts of the uplands. The largest area is in Plant Township and is locally known as the "Jackmorrow Flats." The type is rolling enough in most cases to

give excellent natural drainage. There is an occasional depression to be seen where water accumulates during a heavy rainfall and covers the surface for a few days. The soil is seldom rolling enough to wash badly and is practically all suitable for cultivation.

This soil, like the preceding one, is formed from the loess deposit. The characteristics which distinguish it from the Finney fine sandy loam are due more to the present topographic and drainage features than to any difference in the material from which it is derived. The heavy substratum has increased the water-holding capacity of the type so that it has produced heavy growths of prairie grass for many years, and thus a large quantity of organic matter has been accumulated in the surface soil.

Like the Finney fine sandy loam, this soil was naturally open prairie supporting a good growth of prairie grass, including the buffalo grass and grama. This is a very productive soil and adapted to a large diversity of crops. The crops are held in check and their growth controlled more by the moisture supply than by the fertility of the soil. The cereals, including corn, wheat, and oats, are well adapted to this type. Alfalfa, clover, brome-grass, and fescue are crops that will do well, though frequently they are injured by drought.

Corn and wheat are the principal crops grown. Corn yields from 25 to 40 bushels per acre or even more unless it has suffered from lack of moisture. Wheat yields from 15 to 35 bushels, with an average of perhaps 25 bushels in favorable years. Oats give fair yields, but are not extensively cultivated. Alfalfa yields 2 to 3 tons to the acre, and is the only legume grown on this soil. Probably 50 per cent of the type is still in pasture. These pastures are very productive and in most seasons 3 acres are sufficient to support one steer.

The same cultural methods are employed on this type as on the types in the valley. The farmers on the Finney loam must depend upon the rainfall for their water supply, since there is no available water for irrigation. Frequent and shallow cultivation is to be recommended. The soil should be stirred as soon as practicable after a rain in order to form a surface mulch to prevent the evaporation of moisture absorbed by the soil. Fall plowing would be a good practice on this type, since it is seldom rolling enough to wash. Early fall plowing and possibly subsequent stirring with a harrow or disk would enable the fall and winter rains to permeate the soil and in this way moisture would be conserved for the coming crop. In short, it would be well to employ the most perfected methods of dry-land farming, for, although there has been sufficient rainfall the last few years to produce large crops with no especial attention being paid to the conservation of moisture, it is certain that in most years crops will suffer in this section of the country unless care is taken to utilize the rainfall in the most economical manner. This type of soil is sel-

dom fertilized, even the farm manure being commonly left to decay in the barnyard or else is hauled away and dumped into some ditch or waste place.

The farmers value this soil at \$20 to \$40 an acre, the average valuation being about \$25.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Finney loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16822, 17767.....	Soil.....	0.1	0.1	0.1	4.3	45.0	39.9	10.5
16823, 17768.....	Subsoil.....	.0	.1	.2	5.2	50.4	36.9	7.1

DUNESAND.

The Dunesand consists of a rather fine-textured, yellowish-gray sand 36 inches in depth. The surface 6 or 8 inches contains a small accumulation of organic matter which gives it a slightly darker color. There are numerous depressions scattered here and there through this type, and in these lower areas the surface soil contains more organic matter and is of a more loamy nature. In the very lowest parts of these depressions the surface few inches may be a sandy loam.

This is by far the most extensive soil type in the survey. It occupies all the upland north of the valley and a large area is found on the south side bordering the loess deposit. This type presents the typical sand-hill topography of western Nebraska. It consists of a monotonous continuation of sand dunes, with an occasional depression or basin between. These hills are frequently 150 to 200 feet in height. There is no drainage developed in this region, as the sand is so porous that the rain water is readily absorbed by the soil. Whitehorse Creek, which cuts back into the sandhill region south of the river, is fed by springs and probably receives through underground channels the drainage of a rather large area of this type.

The accumulation of sand which gives rise to this soil is derived largely from the Arikaree formation. Darton suggests that this sand owes its origin in part to the remains of the early Pleistocene age or to the extension of the Equus beds of loess.^a The present dune-like topography is due to subsequent æolian forces. Occasional blowouts may be seen in this type and until the last few years of heavy rainfall it was drifting badly in many places. At the present time, however, it supports a scanty growth of bunch-grass, yucca, cactus, and several varieties of wild legumes, which hold the soil in

^a N. H. Darton, Professional Papers No. 17, U. S. Geological Survey, p. 15. 1903.

place. Whenever too heavily pastured or cultivated the sand starts blowing about and great difficulty is experienced in getting it back into grass.

It would seem that grazing will be the only profitable means of utilizing this type. Small areas in the depressions are planted to corn and in favorable years as much as 20 bushels per acre is produced, but many seasons are so dry that the crop is a total failure. Wild hay is occasionally cut from these depressions, and the growing of alfalfa is sometimes attempted, but with little success. Twenty to forty head of cattle are pastured to the section. During the summer months much of the soil will support as many as forty head, but in winter half this number will frequently suffer and often require the pasture to be supplemented with hay and sometimes corn. The area of Dunesand south of the river is more level and not quite as sandy as that on the north and consequently supports a better growth of grass.

In the utilization of Dunesand care should be taken not to overstock the ranges, for, when too heavily pastured, the surface is liable to start blowing. For the same reason the hills should never be broken and care should be employed in the tilling of the depressions, since the surface is very liable to start drifting even in these basin-like areas.

The Dunesand is valued at \$1.50 to \$3 an acre. Areas owned by the railroad may be purchased for \$2.25 an acre.

The results of mechanical analyses of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Dunesand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17781.....	Soil.....	0.5	7.2	10.0	41.8	32.4	5.1	3.8
17782.....	Subsoil.....	.1	4.9	6.4	40.6	37.1	6.8	4.4

OSGOOD FINE SANDY LOAM.

The soil of the Osgood fine sandy loam to a depth of 12 to 18 inches is a light-brown to brown very fine sandy loam. It contains a large amount of silt and frequently grades into a loose-structured silt loam containing considerable fine and very fine sand. The subsoil to a depth of 36 inches consists of a grayish-yellow very fine sandy loam of practically the same texture as the surface soil. The type is less sandy in the eastern part of the area, while in the western part the subsoil is somewhat heavier, resembling that of the Finney loam.

The Osgood fine sandy loam forms a continuous strip across the area from east to west along the south edge of the valley and extends

from the foot of the bluff a mile or more into the bottom land. It is nearly identical with the Finney fine sandy loam, from which it has been formed, and represents merely the upland loess washed into the valley and deposited so as to form a kind of a low, second bottom-land terrace along the south side of the valley. It presents a nearly level surface with a gradual slope to the north. It is not subject to overflow, and though rather level its porous structure gives it perfect drainage.

In the western part of the area there is no sharp bluff line on the south side of the valley, but the bluff slopes gradually down to the low, flat bottom land. In this case the Osgood fine sandy loam occupies a higher terrace and assumes a somewhat different character, being, as before mentioned, more like the Finney loam. In the extreme eastern part of the area the type is found occupying two distinct terraces. Here the streams have carried away enormous quantities of loess from the upland in past years. There seems to have been formed a deep deposit which was subsequently partly eroded by the Platte River. The river has later swung back north, and that portion of the terrace that was removed has been replaced by more recent wash from the bluff, but this deposit has not reached the depth of the older one. This later-formed terrace is of a rather silty nature and the surface soil is deeper than is characteristic of the type.

Generally this wash is not strongly alkaline, but in some places, especially near the outer edge, alkali occurs in large enough quantities to injure the crops. Calcium carbonate concretions and small chips of limestone are scattered through the soil adjacent to the areas of Rough stony land.

One of the most productive soils of the area, the Osgood fine sandy loam is well adapted to the common grain crops, such as corn, wheat, and oats. It is an excellent alfalfa soil, giving from three to four cuttings annually and yielding on an average 4 tons or more to the acre. Beets seem especially well adapted to the soil. Brome grass and fescue should both produce heavy yields of hay. Practically all these crops are grown at the present time. Corn is probably the leading cereal and yields from 25 to 60 bushels, with an average of about 40 bushels per acre in favorable seasons. Wheat averages 20 to 25 bushels, oats 35 to 45 bushels, and sugar beets 15 tons per acre. Some emmer (speltz) is grown and gives good yields. Much of the type is still in pasture, the native sod never having been broken. These pastures are of fine quality, 40 acres generally being sufficient for fifteen to twenty steers. Practically the same cultural methods are employed on this type as on the Finney loam. Corn is universally listed and receives about three cultivations. Some farmers harrow the corn once or twice during early growth. This is a prac-

tice that can be recommended for more general use. Modern hay-making machinery is employed in the alfalfa fields. The irrigation ditch which follows the base of the bluff nearly to the east limit of the area surveyed would, if in good condition, afford a means of supplying water to practically all of this soil. This ditch has been neglected, however, the last few years, and at present is not being used.

Some of the best improved farms in the area are to be found on this soil. The farm buildings are generally very good for a newly settled country, and gradual improvement is being made in this respect. The type is valued at \$30 to \$50 or more an acre, the average value being not far from \$40.

The following table gives the average results of mechanical analyses of this soil:

Mechanical analyses of Osgood fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17783, 17787.....	Soil.....	0.0	0.2	0.1	5.1	37.4	51.6	6.1
17784, 17788.....	Subsoil.....	.1	.1	.2	3.8	34.0	55.2	6.1

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17784, 1.27 per cent; No. 17788, 1.54 per cent.

NORTH PLATTE LOAM.

The surface soil of the North Platte loam is a brown loam with an average depth of about 14 inches. On the higher areas this surface is more of a sandy loam, while in the lower, more level places it becomes a heavy loam. Small amounts of gravel commonly occur scattered through the surface soil. The subsoil consists of a yellowish-brown to drab clay loam or heavy sandy loam. When dry this subsoil becomes very hard and is sometimes incorrectly called hardpan. Generally the texture becomes lighter below 24 to 30 inches, the clayey stratum being from 12 to 16 inches in thickness.

This soil is confined to the valley and is the principal type found between the rivers from North Platte to Hershey. It also occurs in small areas north of the North Platte River and on Brady Island. Adjoining the river near Maxwell there occurs a rather large body of this soil.

Probably of older formation than the other valley types, the North Platte loam owes its origin to alluvial deposits of the rivers, and occupies areas higher than the Laurel gravelly loam or Laurel loam. Very often it is separated from these two types by terraces 6 to 10 feet in height. The soil represents the old valley floor which has been cut away by the rivers in more recent times and replaced at a lower level by deposits of different character, thus in most cases leaving the North Platte loam a true second bottom. The topography is of a

level character, and except in occasional depressions the drainage is good.

The North Platte loam frequently contains injurious amounts of alkali, though it is only in small areas that the concentration of salt is great enough to affect seriously the more resistant crops. Considerable of the type, however, has from 0.05 to 0.20 per cent of alkali in the surface 3 feet in dry seasons. Because of this accumulation of salt it is difficult to get a stand of alfalfa in some instances.

This soil is adapted to a wide diversity of crops. Corn and oats will produce well, while wheat will probably be found to yield less proportionately to these other two cereals. Alfalfa is well adapted to this soil and sugar beets should produce good yields even in the areas containing the most alkali. Fruits and vegetables should prove fairly successful where the soluble salts have not accumulated in large enough quantities to be injurious.

Corn and alfalfa are the principal crops. Alfalfa yields from 3 to 5 tons, and corn from 40 to 60 bushels per acre in favorable seasons or where irrigated. Sugar beets were extensively grown at one time and gave excellent yields of 15 to 25 tons to the acre where well tended. Wheat also was grown extensively, but its acreage has decreased materially within recent years. For a time potatoes were produced commercially, but now only to supply home consumption. Fruit produces fairly well, and apples, pears, and cherries are all grown to a limited extent.

The same cultural methods are employed on this type as on the Osgood fine sandy loam. Irrigation is more extensively practiced, however, and the ditches have been maintained in better condition during the recent seasons of abundant rainfall.

Many well-improved farms are to be found on this soil. Substantial and comfortable farm buildings are common. The North Platte loam and Osgood fine sandy loam have by far the best farm improvement of the area. The North Platte loam is valued at from \$30 to \$75 an acre. The higher areas, which are practically always free from injurious accumulations of alkali and which have rights to a sufficient supply of water, can not be bought for less than \$50 to \$60 an acre.

The following table gives the results of the mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of North Platte loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17771.....	Soil.....	0.7	5.3	2.8	11.4	26.1	41.8	12.0
17772.....	Subsoil.....	1.3	5.8	3.1	10.0	16.8	38.5	25.8

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17772, 0.73 per cent.

LAUREL LOAM.

The surface soil of the Laurel loam to a depth of about 12 inches consists of a brown to dark-brown silt loam which frequently contains large amounts of organic matter. The subsoil is a mealy, slate-colored to gray silt loam extending to a depth of at least 30 inches, below which it often becomes sandy, and frequently the underlying river gravels are encountered above 36 inches. Where the soil is very shallow sandy or gravelly material may be found at 20 to 24 inches. In some places muck is encountered at this same depth, and very often an inch or two of muck immediately overlies the gravel. Considerable mica is found throughout this soil. Along Whitehorse Creek the surface of the type is often slightly sandy, due to the deposition of sand by the creek. This sandy material is never over 6 inches in thickness and has little influence on the agricultural value of the soil.

The Laurel loam occurs as an almost continuous strip along each side of the valley just below the soil washed down from the bluffs. In a few places it extends to the river, but it gives way more often to a gravelly loam or sandy loam soil.

Much of the Laurel loam is covered with water during the wet seasons and as a whole the soil is low, flat, and poorly drained. Only a few small areas were seen that were under cultivation. In general the practicability of drainage is very doubtful, as the fall in many cases is hardly sufficient to carry off the water.

Deposition of material in very slow moving water is the process by which the Laurel loam has been formed. As the river retreated from the edges of the valley there was left an old channel on either side through which water flowed sluggishly when the river was high. This was probably in the nature of a swamp or marsh and gradually this silt deposit was made on top of the river gravels or muck. There is probably some alkali present in this type, but in no case has it accumulated in large enough quantities to injure the wild grasses which naturally cover this soil.

Practically none of the soil is farmed, its principal use being as meadow. The wild grasses yield about 1 ton of hay to the acre. The type is valued at \$15 to \$30, and rents for 50 cents to \$1 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Laurel loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17777.....	Soil.....	0.2	3.0	2.6	14.9	14.8	50.3	13.3
17778.....	Subsoil.....	.1	1.3	1.7	12.2	16.7	44.9	22.6

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17777, 22.80 per cent; No. 17778, 38 per cent.

LAUREL GRAVELLY LOAM.

The Laurel gravelly loam consists of a brown loam soil 12 to 20 inches deep underlain by river gravel or coarse sand. The average depth of the surface soil is about 18 inches. In the vicinity of the Laurel loam the surface is sometimes of a silty character, while on the better drained areas it frequently contains a large percentage of gravel. Near the rivers there occasionally occurs a phase of this type which has a loam to fine sandy loam surface about 8 inches deep. This is underlain by a rust-colored fine sand, which in turn is usually underlain by a coarse sand or gravel at 24 to 30 inches. This phase generally occurs north of the North Platte River, occupying only small adjacent areas.

This soil usually occurs in strips located in the central part of the valley and running parallel to the rivers. It has been formed by the deposition of a shallow layer of loamy material on the sands and gravels which at one time formed the river beds, and in a more rapidly moving current than that which deposited the silt composing the Laurel loam. Like the loam this soil is low lying and poorly drained. It also is more or less alkaline, but does not contain enough salt to injure the growth of the wild grasses.

The Laurel gravelly loam is seldom cultivated, and like the soil just described is utilized largely as meadow. The water table is in most cases at the surface of the gravelly subsoil, and consequently it will be difficult to drain this type thoroughly. There are a few areas that are high enough to be cultivated, but in such cases the surface is so gravelly that it does not return good yields. Some alfalfa is produced on these higher areas, but the yield is low and uncertain.

Land of this type of soil is valued at \$15 to \$25, and rents for 50 cents to \$1 an acre. It is considered of about the same value as the poorly drained Laurel loam.

The following table gives the results of mechanical analyses of a fine-earth sample of the soil and subsoil of this type:

Mechanical analyses of Laurel gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17768.....	Soil.....	4.4	16.6	6.6	13.9	8.8	30.0	18.7
17770.....	Subsoil.....	8.2	29.9	13.9	27.3	8.9	5.4	6.4

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17768, 15.06 per cent; No. 17770, 1.32 per cent.

GANNETT FINE SAND.

The surface soil of the Gannett fine sand from 8 to 12 inches consists of a light-brown sandy loam or loamy sand of rather fine texture. The subsoil is a yellowish sand to light sandy loam. Along the outer edge of the type silt loam or muck occurs at 24 to 36 inches, but generally the sandy material has a depth of at least 30 inches.

This soil is found along the north side of the valley, occupying a strip about a half mile wide at the base of the bluff. There is also one small area along the base of the south bluff. This soil is of similar origin to the Osgood fine sandy loam, but differs from that type in that it has been formed from the wash from the sand hills instead of from the loess uplands. The topography is generally level with a gradual slope toward the valley.

The soil is seldom cultivated, most of it being utilized as pasture. It is of too sandy a nature to produce large yields of the cereals. Vegetables should do well on it, however.

It is difficult to determine the value placed upon this soil, since it seldom changes hands except where other types are sold with it. About \$10 to \$20 an acre would be a fair valuation.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Gannett fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17775.....	Soil.....	0.0	2.8	8.0	49.6	26.0	8.9	5.0
17776.....	Subsoil.....	.0	2.6	7.7	49.7	27.7	5.3	6.4

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17776, 1.95 per cent.

LAUREL SANDY LOAM.

The Laurel sandy loam to a depth of about 12 inches is a light-brown sandy loam or loamy sand, underlain by a yellowish, lighter sandy loam subsoil. The type is similar to the Gannett fine sand, though generally the sand is of coarser texture. Occasionally silt loam is encountered at 30 inches, while in some cases the subsoil contains a noticeable amount of clay at this same depth, especially where the type is associated with the North Platte loam.

The Laurel sandy loam occurs scattered through the valley, occupying higher areas than the surrounding types. Very often narrow strips of this sandy loam are found along the banks of the rivers, in which case it has been formed by the sand blowing from the river beds in dry periods. Other areas occupy low ridges back from the rivers, and in such cases the soil seems to have been formed along old river

channels, either having been built up by the water depositing the sand or by the wind blowing the sand from these old channels. The sandy loam of these ridges is of a coarser texture than that adjoining the rivers.

The soil is well drained and very often in cultivation. It dries out easily and the crops suffer from lack of water in dry seasons unless irrigated. In a few cases alkali has accumulated in small quantities, but seldom is there enough to injure crops.

Alfalfa and sorghum are the principal crops grown on this soil. The greater part of it is still in pasture and meadow. It is valued at \$20 to \$30 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Laurel sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17761.....	Soil.....	0.5	9.1	11.9	34.7	23.1	14.8	6.7
17762.....	Subsoil.....	1.0	9.0	10.3	31.5	26.2	13.9	8.3

MUCK.

The area classed as Muck consists of 6 to 20 inches of black, decomposed organic matter, underlain by a gray silt loam, a heavy black-clay loam, or by river sand and gravels. The type includes low, marshy areas which are covered with water the greater part of the year. It still supports a rank growth of the native vegetation, consisting of rushes, mosses, cattails, and other aquatic plants. This rank growth has been the source of the large amount of organic matter present in the surface soil. The marshy conditions have preserved it by preventing complete oxidation, and as a result Muck with its black surface of decomposed organic matter is found.

The type in its undrained condition is of little or no agricultural value. A very small percentage is drained well enough to produce swamp hay.

ROUGH STONY LAND.

There are a few small areas of Ogalalla limestone exposed from under the loess along the south side of the valley. This limestone is badly weathered and broken into fragments, which cover the surface so that the land is nearly worthless. These small areas have been mapped as Rough stony land. They are very rough and broken and are of little agricultural value. A scanty growth of grass allows some grazing, but the type can never be put into cultivation.

RIVERWASH.

The Riverwash consists of rather coarse waterworn sand and gravel. The gravel occurs in strips, having been deposited in the more rapid currents. The soil occupies the channel of the South Platte River. Frequently during wet seasons it is entirely submerged, and is washed about and more or less rearranged by the current, while at other times the river dries up entirely and the soil is blown about by the wind. The Riverwash supports no vegetation whatsoever, the sand and gravel being utilized for building purposes and road construction.

IRRIGATION.

The North Platte irrigation canal, which is one of the oldest in the State, was completed in 1884. For ten years subsequent to this practically no construction work was done. In 1893 and 1894 interest was again aroused, and between the years of 1894 and 1896 all the other canals of importance in the area were constructed.

With the exception of the Birdwood and the South Side canals, all those of importance are situated between the two rivers and depend wholly upon the North Platte River for their water supply. Often this supply is inadequate, especially in very dry times, when water is most needed. The South Side Canal, which is at present practically abandoned, has received its water largely from the South Platte River, but it was so planned that when this river was dry it could draw upon the North Platte. This canal has not been used during the last few years, and is now in such poor repair that it would require a large outlay of capital to put it in condition.

The Birdwood Canal extends along the north side of the valley. It receives its water supply from Birdwood Creek, which enters the North Platte Valley about 16 miles west of North Platte. This stream is fed by numerous springs occurring along its course through the sand hills. Often the flow of this stream is not sufficient to supply the water demanded. Water Supply and Irrigation Paper 184, United States Geological Survey, states:

The discovery of the artesian head of the water in Birdwood Creek makes it possible to augment greatly the low-stage flow of this stream and the supply of water for the existing irrigation canal or a new one. It will not be an expensive matter to sink a number of 12-inch wells to the artesian water at suitable localities along the stream and to provide these wells with gates or valves which can be opened during low stages of flow. It is very probable that the present minimum flow of Birdwood Creek could be doubled by this means.

The following table shows the composition of water taken from several sources in the area. The determinations were made in 1895 by the United States Geological Survey.

Chemical analyses of irrigation water.

[Parts per million.]

Location.	Chlorine.	Alkalinity, as CaCO ₃ .	Hard- ness, as CaCO ₃ .	Total solids.
North Platte River.....	11.3	130.5	158	300
Spring at head of West Birdwood Creek.....	None.	91.5	60	90
Valley of West Birdwood Creek, 7 miles below spring	None.	91.5	58	80
City water works well, North Platte.....	46.8	192.5	316	600

The object of the study of the underflows of the South Platte Valley carried on by the United States Geological Survey in 1895 was to determine the amount and character of the underflow and whether it was practicable to utilize it for irrigation purposes. The authors make the following statement as the result of this investigation:

The investigations in the South Platte Valley indicate that there is an ample supply of ground water for a large number of small pumping plants located in almost any part of the bottom lands. It is possible to count on an average depth of 40 to 60 feet of good water-bearing gravels. These deposits contain a sufficient amount of coarse material to render it unnecessary to use fine-meshed strainers in the wells. In a large portion of the bottom lands the distance to water is between 5 and 15 feet, making it easy to pump the water and place it on the surface of the ground economically. The cost of pumping will be controlled, primarily, by the cost of fuel and the distance it is necessary to lift the water. Whether the pumping plant will be a profitable investment depends, of course, very largely upon the crops that can be grown and marketed at a fair price.^a

The present canals, if all in good condition and supplied with a sufficient number of laterals, would allow the irrigation of 50 to 75 square miles in the area, and this includes most of the land possessing sufficient drainage to allow cultivation. There has been little irrigation done the last few years, as the rainfall has supplied sufficient moisture for the crops. Probably 50 per cent of the arable land in the valley can be irrigated at the present time. Practically all of the irrigation is done by the use of shallow surface ditches.

ALKALI.

Alkali in this section of the Platte Valley occurs in harmful quantities only in small areas. All of the soils of the valley run high in soluble salts, and during a number of continued dry seasons it is possible that injurious quantities may accumulate near the surface unless care be taken in the handling of the soil to prevent the continual rise of the salts from below. In the two or three seasons just preceding the soil survey the rainfall was relatively heavy, and it is very probable that at this time the alkali instead of being in the surface is distributed throughout the soil, having been carried down by percolating waters.

^a Water Supply and Irrigation Paper No. 184, U. S. Geological Survey, p. 29.

The worst affected area of any great extent lies between the rivers in that section reaching 3 or 4 miles west from the town of North Platte. Even in this area good crops are being produced on the greater part of the soils. There are spots varying from a few square rods to 5 or 10 acres in extent scattered through this section that contain large enough quantities of salt in the surface soil to be injurious to most crops. The North Platte loam is unquestionably the worst alkali soil of the area. Injurious quantities occur in small areas along the outer edge of the Osgood fine sandy loam on the south side of the valley. The meadow land, comprising the greater part of the Laurel gravelly loam and the Laurel loam, does not contain injurious quantities of alkali, a concentration of 0.20 per cent seldom occurring in the surface soil. During continued dry weather, however, enough salt may accumulate in the surface of these soils to injure crops, because the ground water is so near the surface and is always impregnated with more or less alkali.

The alkali owes its origin largely to the accumulation of soluble salts carried down the valley by the underflow of the two rivers. The constant rise of this underflow and subsequent evaporation from the surface has caused the accumulation of the alkali in the upper soil. It is also very probable that considerable quantities have accumulated from the wash from the uplands.

The chemical composition of this alkali is variable. From the analyses made of samples of the surface foot it has been found that it consists mainly of the salts of sodium, potassium, and calcium. The sulphate and chloride forms predominate, but considerable carbonate is found in some of the samples. Sodium carbonate, commonly known as black alkali, is seen in only a few very small areas.

Throughout the valley the alkali seems to have a very irregular vertical distribution. During the spring and early summer months, when there is considerable rainfall, the highest concentration is generally found in the second or third foot. In the late summer and fall, as the rainfall becomes less, the constant evaporation brings the salts to the surface, so that from August on through the fall the surface foot generally contains the largest percentage of alkali. In the North Platte loam the highest concentration is very commonly found at the upper part of the heavy clay stratum which so generally forms the subsoil of this type. In order to prevent the increase of the alkali in the upper soil care should be used where irrigation is practiced and excessive amounts of water should not be applied to the land. Thorough and frequent cultivation should be given such crops as corn and sugar beets, in order to keep surface evaporation at a minimum. For this reason these crops should be cultivated as soon after irrigation as the soil can be worked. Many of the small areas now affected can be reclaimed by thorough tilling.

SUMMARY.

The area surveyed has an extent of about 470 square miles, situated wholly in Lincoln County, Nebr. It includes the valley of the Platte rivers from Hershey to Maxwell and extends into the uplands on each side of this valley. The valley is flat and in places poorly drained, while the upland, generally speaking, is rough and hilly and not suitable for cultivation. North Platte is the largest town in the area. The Union Pacific Railroad affords excellent transportation facilities.

The climate is semiarid. The annual precipitation varies from a little over 11 to 30 inches, the average being about 18 inches. There is an exceptionally large proportion of sunshiny days in this section of the State.

The agriculture of this area began to make rapid development between 1880 and 1885. Much of the valley land is irrigated in dry seasons. Stock raising is the leading agricultural industry. Corn, oats, sugar beets, alfalfa, and wild hay are the leading crops. Modern labor-saving machinery is in universal use. A more systematic rotation of crops should be adopted, and a higher appreciation of the value of farm manure should exist among the farmers.

The soils are of a sandy nature. The uplands north of the river consist of typical sand hills. These hills are of Quaternary formation, though the sand was originally deposited during the Arikaree division of the later Tertiary. Along the south bluff is a deep deposit of very fine sandy loess. Back of this, sand hills are again found. Along each side of the valley is a strip of bench land formed by the wash from the uplands. The remainder of the valley consists of loam, sandy loam, gravelly loam, and silt loam soils generally running in strips parallel to the rivers, and of alluvial origin. There is more or less alkali existing in small patches throughout the valley. Twelve types of soil were mapped in the area surveyed.

The Finney fine sandy loam occupies the area of eroded loess on the south upland. It is too rough for cultivation, is used almost wholly for grazing land, and is valued at about \$10 an acre.

The Finney loam is locally called "hard land." It produces good crops in favorable years. Wheat yields as high as 35 bushels an acre. The type is valued at about \$25 an acre.

The Dunesand is too sandy to be farmed and is used almost wholly as grazing land. It blows badly when the vegetation is destroyed. The type is valued at from \$1.50 to \$3 an acre.

The Osgood fine sandy loam occupies the bench land in the south edge of the valley. It has been formed by the upland loess washing into the valley. This is a very productive soil, producing large yields of corn, wheat, and alfalfa.

The North Platte loam occupies the higher areas in the valley. It is a very productive soil and is valued as high as \$75 an acre. Small areas contain alkali in sufficient quantities to injure crops.

The Laurel loam occupies low, poorly drained areas in the valley and is practically never cultivated.

The Laurel gravelly loam, also a low-lying soil, is utilized mainly as mowing lands.

The Gannett fine sand is too sandy to produce large yields of cereals, though vegetables should do well on it. It is seldom cultivated, the most of it being used for pasture. Its value is about \$10 to \$20 an acre.

The Laurel sandy loam is well drained and often under cultivation, but in dry seasons crops suffer from drought unless irrigated. Small quantities of alkali are found, but do not materially interfere with the growth of crops. Alfalfa and sorghum are the principal crops. Its value ranges from \$20 to \$30 an acre.

There are small swampy areas in the valley which have been mapped as Muck. Along the south bluff outcrops of Ogalalla limestone give rise to small areas of Rough stony land. The bed of the South Platte River has been mapped as Riverwash.

SOIL SURVEY OF THE MORTON AREA, NORTH DAKOTA,

By THOMAS D. RICE, assisted by RAY BABCOCK and JOHN T. WEAVER.

DESCRIPTION OF THE AREA.

The Morton area comprises 544 square miles of territory near the southern border of the State of North Dakota and west of the center. The area is rectangular in shape and embraces 16 townships, namely, Townships 131 and 132 north and Ranges 85 to 92 west, inclusive. About three-fourths of the area lies in Morton County and the western side includes a portion of Hettinger County and a small part of Adams County. The southeastern corner of the area takes in about 1,750 acres of the Standing Rock Indian Reservation.

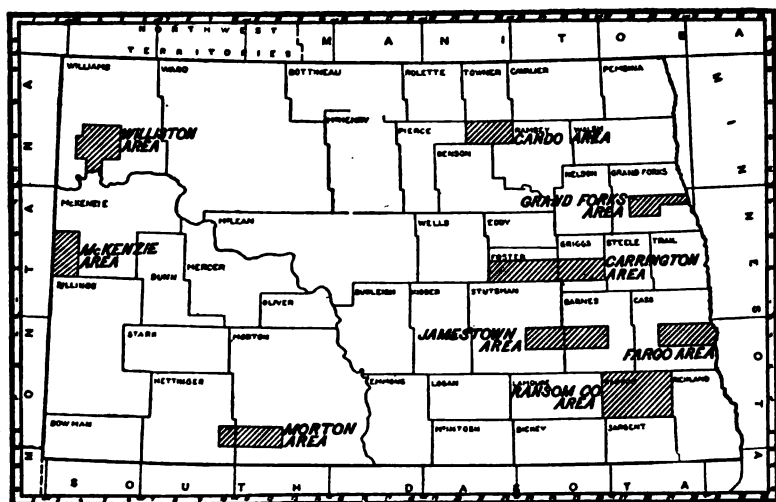


FIG. 28.—Sketch map showing location of the Morton area, North Dakota.

The entire area lies within the drainage basin of the Cannon Ball River, which enters the northern border of the rectangle about midway of its length from east to west and flows in a southeasterly direction toward the southeastern corner. Cedar Creek, a large tributary of the Cannon Ball, sometimes known as the South Fork of Cannon Ball, flows south of the border of the area and parallel to it for a long distance, entering the area in the southeastern corner, and empties into the Cannon Ball. The Cannon Ball continues its course eastward and empties into the Missouri. The local drainage of the

Morton area is effected by numerous small water courses which pursue parallel courses toward the Cannon Ball or the Cedar. They are all intermittent in character, and, with the exception of a few of the largest, become dry after a few weeks of dry weather. The streams fed by springs have pools of standing water along their courses even during protracted droughts, though no stream, except the Cannon Ball and Cedar, will flow after weeks of dry weather.

This region, in common with the whole of southwestern North Dakota, is a great plateau, elevated to a height of nearly 2,000 feet above sea level and more or less carved and modified by the forces of weathering and erosion, to which it has been exposed for ages. The great ice sheet which scoured across the northern part of the State and so greatly influenced the topography did not extend this far south, and the only evidence of ice action in this area is the beds of gravel on some of the higher hills in the eastern part, north of Wade, which were brought down by the outwash from the front of the melting ice.

There are two main topographic divisions, the stream valleys and rolling upland. Along the larger streams, as the Cannon Ball, there are alluvial flats built up by the streams in times of overflow. They are in many cases only a few feet above the present level of the stream and are subject to flooding at frequent intervals. Above the lower flats are a number of imperfectly defined terraces, successively occurring at higher levels until the high plateau is reached. The entire belt of alluvial land in the several terraces is rarely more than 1 mile in width.

The character of the upland is dependent upon the amount of erosion that has taken place. The small streams and drainage courses have as a rule cut out broad, gently rolling valleys, well suited to farming. Near the origin of these streams there are frequently areas several square miles in extent where good drainage has not been established but where the land can easily be drained by ditching. Away from the streams the country ranges from gently to sharply rolling. In a few small areas where the streams have cut rapidly through soft shales and sandstones a topography has been developed typical of the semiarid plains and known in North Dakota as "Bad Lands." Steep slopes, flat-topped buttes, and narrow alkali flats characterize these localities. Such areas are generally useless for farming, but make excellent land for grazing. The total amount of such land in the Morton area amounts to only a few square miles. The most extensive topography is that of the rolling upland, which covers wide stretches of country.

The most prominent features of the landscape are the high hills or buttes that rise above the general level of the region and serve as landmarks that can be seen for long distances. These hills are of two

types: The flat-topped buttes, of which the Coffin Buttes are a good example, and the steep hills thickly covered with chert and sandstone fragments, as in the case of Pretty Rock Buttes.

The present population in this part of North Dakota is composed of two classes, whose interests are to some extent antagonistic. The ranchers or cattlemen comprise one class. They are the pioneers of the region, who pushed out even before the country was safe from the Indians, and at first led a rough life caring for their herds of horses and cattle. Within the last few years has come in the second class, composed of homeseekers from the older States, who have homesteaded upon public land, built houses and barns, and turned the region from a grazing to a farming country.

The new settlers have come largely from Iowa, Wisconsin, and the eastern part of North Dakota. They are not entirely unfamiliar with the conditions that they encounter and expect to undergo many hardships before they make a success. There is also quite a number of foreigners, Norwegians, Germans, Hungarians, and Russians, but the most of them have had experience farther east before coming to this area.

There are as yet no towns in the area and no settlements of any size. It is not likely that any towns will grow up until the proposed line of the Northern Pacific Railroad is built through the area and the townsites are located to suit the conditions that arise. There are at present four post-offices in the area, two of which are volunteer offices. Wade is one of the oldest and best-known places in the area.

The Morton area at the present time is poorly provided with transportation facilities, and if there was no prospect of improvement in the means of getting agricultural products to markets the outlook for general farming would be very gloomy. Until the present year all products not consumed in the area were shipped by the Northern Pacific Railroad from Mandan, Glen Ullin, Richardton, and other points. This necessitated a haul by wagon of 55 to 75 miles. During the summer of 1907 the Chicago, Milwaukee and St. Paul Railway opened a line 12 to 20 miles south of the border of this area, and there seems to be little doubt that the Northern Pacific Railway will in the near future build a road through the area. Surveys for this purpose have already been made, and the general impression is that the road will soon be built in order that the company may secure the land granted by the government. The long haul necessary at the present time makes it unprofitable to grow the ordinary agricultural products, but there has been a good local demand for potatoes, oats, and other feed stuffs. The railroad construction camps have taken large quantities of these products, and the new settlers have for a time had to buy enough to live on while making the first crop.

Cattle and sheep are shipped by the carload to the Chicago and the St. Paul markets. They are driven in large herds to the nearest railroad shipping point. Before the completion of the new road to the south of this area Mandan handled the greater part of this traffic, but during 1907 large shipments have been made from Lemmon, on the Chicago, Milwaukee and St. Paul Railway.

The area is abundantly provided with cheap fuel in the lignite deposits that outcrop over the upland. The lignite beds are sometimes 6 to 14 feet in thickness and furnish a good fuel for domestic purposes. Only the thickest and most accessible of these beds are now worked, but these are of such frequent occurrence that no settler is more than a few miles from a good mine.

CLIMATE.

The following table, compiled from the records kept at Glen Ullin and at Dickinson, show the normal monthly and annual temperature and precipitation for these places. While both of these stations are north of the Morton area, their climatic conditions are so nearly the same that these figures may be considered as representative of the area surveyed.

Normal monthly and annual temperature and precipitation.

Month.	Glen Ullin.		Dickinson.		Month.	Glen Ullin.		Dickinson.	
	Tem- pera- ture.	Precipi- tation.	Tem- pera- ture.	Precipi- tation.		Tem- pera- ture.	Precipi- tation.	Tem- pera- ture.	Precipi- tation.
	° F.	In.	° F.	In.		° F.	In.	° F.	In.
January.....	12.2	0.35	10.3	0.40	August.....	66.8	2.46	67.8	0.97
February.....	10.4	.45	11.7	.41	September...	56.7	1.54	57.0	.60
March.....	22.8	.80	23.5	.96	October.....	44.3	.....	44.2	.89
April.....	41.9	.63	42.6	1.83	November...	28.0	.36	26.8	.56
May.....	52.0	1.66	52.8	2.34	December...	17.5	.43	19.1	.40
June.....	62.1	2.72	61.1	2.23					
July.....	68.1	1.33	68.5	2.37	Year..	40.2	.....	40.4	13.96

The area, in common with the whole of the high plateau of Montana and the Dakotas, is subject to wide variations in temperature. The periods of extreme heat in summer never last longer than a few days at a time, and the nights are nearly always cool. The cold periods in winter are more extended. The mercury may stand below zero for days or weeks at a time, frequently dropping to -30° F. or lower. The uniformity of the cold and the dryness of the atmosphere, however, make the winters in this region much more endurable than over a large part of the United States where alternate freezing and thawing take place and a damp atmosphere adds to the unpleasantness and danger of the climate. In this region the snow-fall in ordinary winters is light and soon blows off the hills. Cattle

and sheep are expected to graze all the winter and little provision is made by the ranchers for feed and shelter. With ordinary care the losses are surprisingly small. Heavy losses are occasioned by heavy snowfall when there is no wind to clear it off the grazing land, but a reasonable preparation for such emergencies would entirely obviate these losses.

The table given below shows the dates of the first and last killing frosts for a period of seven years.

Dates of first and last killing frosts.

Year.	Glen Ullin.		Dickinson.		Year.	Glen Ullin.		Dickinson.	
	Last in spring.	First in fall.	Last in spring.	First in fall.		Last in spring.	First in fall.	Last in spring.	First in fall.
1899.....	June 1	Sept. 19	May 17	Sept. 18	1903.....	May 5	Sept. 12	May 20	Sept. 4
1900.....	May 4	Sept. 15	...do....	Sept. 16	1904.....	May 14	Sept. 13	May 14	Sept. 11
1901.....			May 7	Sept. 17	1906.....	May 27	Sept. 29	May 26	Sept. 26
1902.....	June 21	Sept. 12	May 26	.....	Average.	May 22	Sept. 17	May 18	Sept. 15

It is a rare occurrence that much damage is done by frost before the middle of September, and it is usually several weeks later before vegetation is seriously affected. It will be seen by the records that these stations have an average of 118 and 119 days, respectively, free from frost, which is amply sufficient for the crops usually grown in this latitude. There has been considerable discussion as to whether corn could be profitably grown in the season free from frost. Many of the new settlers coming from corn-growing States have attempted to grow corn here. It has been clearly proved the slowly growing varieties have little chance of coming to maturity, but there has been a gratifying improvement in the early varieties, and in ordinary years these may be successfully grown. The growing of corn to cut green for feed, however, is entirely feasible and commendable.

The greatest climatic problem in this area and one upon which the future of the country depends is that of rainfall. For a long time this part of North Dakota was classed with the semiarid plains and was considered beyond the limits of safe farming. Records for nearly thirty years show that in that time there were several years during which the rainfall was insufficient to grow crops and many years of scanty precipitation. The records given above show for this region the scanty annual average of less than 15 inches of rain. For the last five or six years there has been sufficient rain during the growing season to produce good crops, and this has given an erroneous impression to the new settlers as to what may be expected in the future. There has spread the idea that climatic conditions have permanently changed, and this is attributed by some to the settlement of the region and the plowing of land. While there is no foundation for this belief,

the records show that the years of deficient rainfall are of rare occurrence and the average of good years is sufficient to make farming profitable. The good farmer will not involve himself financially so that one dry year will bankrupt him, and he will in his farming use the most approved dry-farming methods in order to make the best use of the moisture he has in the soil. If he will take these precautions there is no reason why he should not be very successful in the long run and hold an average of profits from his farming equal to those of the farmers in almost any other general farming section.

AGRICULTURE.

The conditions that prevail in this part of North Dakota are those of a country changing its system of agriculture from grazing to farming. Until within the last few years the only settlers were ranchers, living along the stream courses at intervals of several miles. Many of these ranchers came in as soon as the country was opened up and grazed their cattle upon the vast stretches of public land. The excellent pasture, hay, and water made this industry very attractive, and a good living—in some cases a moderate fortune—was gained by the cattlemen at a minimum of expense and labor. Too much praise can not be given these pioneers as a courageous and hospitable people, but the cattle business did not develop the agricultural resources of the country. In rare cases the ranchers sowed oats and feedstuffs, but in most cases they cut enough of the native prairie grass to carry their live stock through the worst of the winter. As already stated, for a long time the impression prevailed that farming could not be successfully carried on in this region with its average rainfall. A succession of years of abundant rainfall, however, caused a great rush of settlers into the whole of the semiarid region and it was inevitable that the good land along the Cannon Ball River would not long be neglected. The spring of 1906 saw very few settlers of the permanent farming class in this area, but in less than two years the country has been thickly dotted with farmhouses and practically every quarter section of public land that would possibly produce a living for a family has been taken up.

The first crops attempted by the new settlers are "sod" crops of wheat, oats, and flax, and potatoes and other vegetables for home use. On account of the long distance to market flax, and, in many cases, wheat, were not profitable crops. Oats, potatoes, and feedstuffs found a good local demand during the last year, as many of the new settlers were compelled to buy these commodities while they were growing their first crop. The summer of 1907 was favorable, and the farmers that were fortunate enough to get in crops had good returns.

None of the farmers as yet have planned any system of crop rotation or method of farming. These things will come later when they have become more accustomed to their land and climate.

Labor has been fairly abundant, as many of the homeseekers were without means and were compelled to earn their living while proving up their claims. It is a common custom for the farmers to exchange work during the busy seasons, when it is desirable that a number of hands should hasten the work.

A very small part of the land is now under private ownership. About one-third of the land in the Morton area, comprising the odd-numbered sections over a large part of it, is owned by the Northern Pacific Railroad Company, having been obtained by a grant from the Government on condition that the company construct a line to furnish transportation to this part of the State. This land has not yet been placed upon the market for sale. The greater part of the remainder of the area is public land. While homestead entry has been made upon all the desirable land, very few of the homesteaders have as yet obtained title, but many will prove up in a short time. No land has been sold recently in the area, but the farming land is valued at \$8 to \$15 an acre and the rougher grazing land at \$2 to \$8.

In North Dakota the farmers are not compelled to fence against cattle, but while the ranchers have been much inconvenienced by the sudden influx of settlers, both sides have exercised patience and no trouble has resulted. Although it will be many years before the cattle business will be entirely broken up, the present system of large ranges will in the end have to be abandoned. It is certain, however, that this will always be a mixed farming and grazing country. It would be a wrong system of agriculture that did not utilize the large area of rough land which affords such excellent pasturage. It would be well for all farmers to take up the raising of live stock as early as possible, so that they will not have to depend entirely upon the farming when dry years come. Horses and sheep are especially profitable. They could be herded by the farmer or his family on the public range when there is no other work to be done, and in busy seasons they could be pastured.

SOILS.

In order to understand the topography of the western part of North Dakota and the reasons for the diversity of the rock formations and the present position of the soils, it is necessary to know something of the geological history of the region. The whole of the Morton area is upon what is known as the Missouri Plateau, a great region now elevated to a height of 1,800 to 2,000 feet above sea level. This plateau is composed of nearly horizontal strata of sandstones, limestones, and

shales, with beds of carbonaceous matter and lignite coal known as the Laramie formation. It is quite natural that the materials composing the Laramie should vary in composition, since it represents the deposits on the shores and bottom of a vast brackish sea of Cretaceous time. That shallow brackish conditions and even swamp conditions prevailed is proved by the alkaline and calcareous composition of a large part of these rocks and the presence of the lignite that could only be deposited under swamp conditions. At the end of the Cretaceous period the region was elevated above sea level and the streams began their work of cutting their channels and eroding and carving the region. The great ice sheet that scoured over the northern part of the State during Glacial times did not extend its action this far south, but occasional drift boulders were deposited and remain as gravel beds on the tops of some of the higher hills in the northeast part of the area.

The agencies of weathering and erosion have converted the sandstones, calcareous sandstones, and shales over the greater part of the area into soils, which as seen at the present time vary in texture, color, and other physical properties, either by reason of the character of the original material or because of the processes of decomposition and deposition that the modified soils have undergone. In the Morton area the character of the original rock has doubtless determined in a large measure the nature of the residual soils of the area. The soils of different textures occur alike on the steep rolling hills and the more level valleys, and the forces of modification have been practically the same. There are, however, differences between the soils of this area and those of the humid regions, due to difference in the processes to which they have been subjected, which it is well to note in this connection. In a humid region the rocks, subject to much rain and moisture, decompose more rapidly, so that the soil extends to a great depth, but as we go into the regions which have had a more scanty rainfall for ages we find, as in the Morton area, that the well-decomposed soil material is of shallow depth, and soon passes into the less thoroughly decomposed rock, and the materials which have broken show evidence that disintegration rather than decomposition has been the chief agency in their formation.

In the humid region, when the rocks are broken down into soil, the easily soluble alkali salts are rapidly removed, so that they are never a source of danger, nor are they even noticeable; but in a region of moderate rainfall like the Morton area, with rocks containing much soluble salt, as the Laramie formation, decomposing and setting free these salts, and with waters strongly impregnated seeping out of the coal beds upon the lower land, it is not surprising that alkali is found upon the surface and in excess in the soil. In the Morton area these alkali spots are of small extent and will never be a source of danger more

than at present, but some of them, locally known as "gumbo spots," occurring in cultivated fields, are a source of much annoyance to the farmers.

In the Morton area we have a series of soils derived from the weathering of the rocks of the Laramie formation, known as the Morton series. The Morton fine sand and the Morton fine sandy loam are the more sandy members of the series, derived from the coarser rocks of the Laramie, and the Morton loam is derived from the very calcareous silty member of these rocks, while the Morton clay loam and the Morton clay come from the finer textured rocks, ranging from fine shales to shaly clays. The Morton stony loam occupies those localities where portions of the rock have withstood weathering, and the fragments of broken rock are scattered over the surface, or more often, where bodies of chert have been left in the soil or on the surface where the less resistant sandstones and shales have broken down. The Morton gumbo is an alkali soil of low agricultural value. It occurs where the carbonaceous shales outcrop to form soils or where they immediately underlie the surface.

The alluvial deposits of the area owe their origin to the materials brought down and distributed by the streams in times of overflow. These processes are still adding to the soils of the lower bottoms, but the higher terraces are now above the limits of the floods. Along the smaller creeks the flood-plain soils closely resemble the upland materials, from which the stream has derived its sediments. For instance, along Timber Creek the lowlands are covered by very sandy soils, while along the larger creeks, which have gathered their sediments over large areas of widely varying materials, the soils, separated by the assorting action of the stream currents, range from very sandy loams to heavy clays. The alluvial soils include the Wade fine sandy loam, the Wade loam, the Wade silt loam, and the Wade clay.

The following table gives the name and extent of the several soil types shown in the accompanying map:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Morton loam.....	163, 456	46.9	Wade silt loam.....	3, 136	0.9
Morton fine sandy loam.....	96, 384	27.7	Morton fine sand.....	1, 280	.4
Morton stony loam.....	47, 232	13.6	Morton clay loam.....	1, 152	.3
Wade fine sandy loam.....	12, 008	3.6	Morton clay.....	704	.2
Wade loam.....	8, 576	2.5	Wade clay.....	576	.2
Morton gumbo.....	8, 448	2.4			
Rough broken land (Bad lands).....	4, 672	1.3	Total.....	348, 224	

MORTON FINE SAND.

The Morton fine sand consists of 10 inches of a very fine silty sand of light-brown color, underlain by a fine silty sand of lighter color, which usually contains more silt. The soil is loose and incoherent and carries very little organic matter. The subsoil at a depth of 3 feet or less passes into the partly altered sandstone from which it has been derived.

The Morton fine sand is the most sandy member of the soil series derived from the weathering of the Laramie rocks. It owes its origin to the coarseness of the original rocks and to its position, which has allowed the removal of the finer materials as they were released by the decomposition of the rock.

The soil occupies the flat tops and in places the slopes of a few high hills or buttes. Its sandy nature and topography render it unable to retain moisture, so that the areas have a very low agricultural value. It has, however, considerable value for grazing. While the grasses on these sandy hills are not so rank as on some of the heavier soils, they are of the most nutritious varieties.

The following table gives the results of mechanical analyses of the Morton fine sand:

Mechanical analyses of Morton fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17604.....	Soil.....	3.0	1.1	0.4	5.6	33.6	52.1	4.4
17605.....	Subsoil.....	.3	.3	.2	3.2	46.0	47.7	2.7

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17604, 12.80 per cent; No. 17605, 18.70 per cent.

MORTON FINE SANDY LOAM.

The Morton fine sandy loam consists of a brown fine sandy loam to an average depth of 18 inches, underlain by a fine sandy loam usually lighter in color.

The soil is slightly coherent, especially where organic matter is present in some quantity, has a loamy character, and does not break up under the plow into a loose, sandy condition. The subsoil, which usually contains more silt than the soil, becomes more silty in texture and lighter in color at lower depths.

The Morton fine sandy loam is one of the most extensive soil types of the area, being found throughout the region where the Laramie sandstones have weathered. It occurs in all parts of the upland of the Morton area in strips and spots of various sizes. It may occur as small areas covering a single hill or as extensive stretches including many square miles. As a rule, however, the hills and rolling sections are more likely to be sandy than the level land.

The entire area covered by this type is well drained and a large portion of it is excessively drained, so that regular farming on the very sandy rolling land will be very uncertain in dry seasons. Where the land is not hilly good crops will be grown on this type in seasons of average rainfall.

The Morton fine sandy loam is derived by weathering from the more sandy rocks of the Laramie formation. This being a region of moderate rainfall, weathering has not taken place to any great depth. In some places hard sandstone is encountered at less than 3 feet below the surface, and such areas are of doubtful agricultural value. In other places the rock may have decomposed into soil to a depth of 10 to 20 feet, but the average depth at which the altered sandstone is struck is not far from 4 feet. Occasional stone fragments are found over nearly all areas of this type, being either portions of the sandstone that have resisted weathering or bodies of chert that were distributed through the original rock.

The Morton fine sandy loam is a very productive soil, and when well watered all the crops suited to the region may be grown upon it with success. Where there is rock near the surface or where the subsoil is very sandy and unsuited to retain moisture, it is unwise to depend upon the cultivated crops for a living, but such areas may be utilized for stock farming in connection with better soils. The whole of the Morton fine sandy loam is well adapted to grazing, having in its unbroken state a good growth of native grasses. The portions of the type now under cultivation produce good crops of flax, oats, and potatoes, and fair yields of wheat. The texture of the soil adapts it to truck crops and vegetables that require a rapid growth during a short season. For this reason it is better adapted to corn than are some of the other soils, but the possibility of injury from drought is greater than in the heavier soils.

The following table shows the results of mechanical analyses of typical samples of the Morton fine sandy loam:

Mechanical analyses of Morton fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16979.....	Soil.....	0.0	2.3	7.3	44.7	14.0	24.3	7.2
16980.....	Subsoil....	.1	2.4	8.5	45.3	13.7	22.1	7.7

MORTON LOAM.

The Morton loam is the most extensive and the most valuable of the upland soils of the Morton area and the one upon which its future agricultural prosperity depends. To a depth of 18 inches the soil is a brown loam, with a large percentage of silt, and passes in many places into a silt loam. The subsoil where typical conditions prevail is a light-colored, almost white, silt loam, which usually extends

without change to a depth of more than 40 inches. The Morton loam is found over nearly the whole of the upland portion of the area. The most valuable stretches of this type for farming are some of the broad valleys, but the soil is not confined to this topography, extending as well over the rolling hilly country and in some cases covering rounded hills that stand above areas of more sandy soils. The townships that have the best farming land of the area are largely covered by this type of soil. Large tracts are found in several townships comprising broad valleys, among them T. 131 N., R. 87 W., and T. 132 N., R. 92 W., have the largest proportion of good farming land of this soil.

The Morton loam is derived from the very calcareous sandstones of the Laramie, which break down into a silty mass but finally weather into a silty loam soil. Drainage is naturally good—a result of the open texture of the subsoil and of the topography. On the other hand, the texture and structure of the soil enable it to retain moisture well, and this feature will greatly enhance its value over the fine sandy loam when dry years come.

The Morton loam, especially the well-situated level portions, was eagerly seized by the first homesteaders, and now practically every quarter section that contains enough of the soil for a farm has been entered. The early homesteaders have now had two crops and the success for these years has been very encouraging. Wheat, flax, oats, corn, and millet have been successfully grown and yields have been good. As much of the land has been put into cultivation for the first time and in most cases a sod crop was planted, the capacity of the soil has not yet been determined. It has been clearly demonstrated that it is a strong soil, suited to all the ordinary field crops of the area, and that there are no especial difficulties in the way of cultivation. All the crops enumerated have given good yields, and vegetables for home use, such as potatoes, cabbage, peas, and root crops, may be grown to perfection. With reasonable caution and the practice, as far as possible, of the dry-farming methods, there is no reason why the farmer on this type of soil should not make a success.

There are two exceptions to the general excellence of the Morton loam that must be noted. In some of the areas mapped as Morton loam, while the soil is typical, it covers rolling hills and in some cases contains much stone. Another phase is the rather unproductive portion of this type about the center of T. 132 N., R. 89 W., and in T. 131 N., R. 92 W., which approaches "gumbo" in character. These lands have been recognized by the new settler and avoided. They are especially undesirable in droughty years. Where the lignite or the strata containing much soluble salts do not come too near the surface, the unproductiveness is caused by surface accumulations of alkali, the effects of which will readily disappear under cultivation, but too much caution can not be exercised in taking up these lands.

In a native state the Morton loam is covered by a luxuriant growth of excellent range grasses and the type constitutes the best grazing land of the area. Some of the rougher land of the type is especially good pasture. The grass grows high enough to make a good yield of hay and all the smoother areas of the soil are mowed.

The following table shows the texture of typical samples of Morton loam:

Mechanical analyses of Morton loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17009, 17595, 17597.	Soil.....	Tr.	1.0	2.1	20.5	11.1	46.0	18.7
17010, 17596, 17598.	Subsoil.....	0.1	.9	2.3	12.6	5.8	50.5	27.7

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17596, 16.38 per cent; No. 17598, 26.88 per cent.

WADE SILT LOAM.

The Wade silt loam is one of the most desirable types of soil found in the Morton area. It consists of a brown silt loam having an average depth of 18 inches, underlain by a gray to yellow silt loam, usually containing about the same percentage of silt and slightly more clay. The Wade silt loam has a large accumulation of humus, which gives the dark color to the soil and the loamy character that makes it easily tilled. It differs from the silt loam of the upland in being of alluvial origin and in having more organic matter.

The Wade silt loam is found in several tracts, most of them in the eastern half of the area. They occur in high valleys in the upland, which show evidence of having been poorly drained before the stream channels were as well established as they are at the present time.

The areas of Wade silt loam usually lie well for farms, being gently sloping and well drained. A considerable portion of the type is cultivated, as it is a favorite type of soil with the homesteader and was one of the earliest to be settled. The soil is very productive and withstands drought well. Wheat, oats, flax, barley, corn, and millet are grown. It is well adapted to any of the usual field crops. The average yield of wheat is 25 to 30 bushels per acre.

The following table shows the composition of a sample of the soil and subsoil:

Mechanical analyses of Wade silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16981.....	Soil.....	0.0	0.5	0.3	7.4	10.3	62.1	19.5
16982.....	Subsoil.....	.1	.5	.4	7.7	11.9	58.3	21.0

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16982, 6.31 per cent.

MORTON CLAY LOAM.

The surface soil of the Morton clay loam is a heavy silty clay loam to an average depth of 16 inches, containing sufficient humus to give it a dark-brown color. The subsoil is a heavy silty clay loam of light color passing into a light-colored very silty clay and in some cases into a mass of almost pure silt. While the top soil is in some cases nearly as heavy as that of the Morton clay, the subsoil does not pass at lower depths into the shaly clay of the latter type.

The Morton clay loam, on account of its limited area, is a comparatively unimportant soil. It covers numerous small areas, many of them less than 2 acres in extent and too small to indicate on the map. There are two areas that are nearly 1 mile in width, but the total area is only 1,152 acres. As a rule it occupies small, rounded hills or knolls or in some cases slopes of such hills. The type owes its origin to the outcropping and weathering of the finer-grained calcareous rocks of the Laramie. The difference in texture between this soil and the Morton clay is probably due to a difference in the character of the original rock.

Not enough of the Morton clay loam has been brought under cultivation to judge by observation of its productiveness, but from its native vegetation it may be inferred that it has great value for certain purposes. The presence of the soil in the field may be detected by the luxuriant growth of grass which everywhere covers it. It is without doubt the most valuable grazing land of the Morton area, although its small extent lessens its adaptability for this purpose. Wheat and timothy should flourish, and all crops should resist drought on this type of soil.

The following table shows the results of mechanical analyses of typical samples of the Morton clay loam:

Mechanical analyses of Morton clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17599.....	Soil.....	0.1	1.3	0.6	5.0	11.8	52.9	27.4
17600.....	Subsoil.....	.0	.5	.3	2.6	6.8	61.5	27.8
17601.....	Lower subsoil ..	.1	.7	.2	2.0	9.1	59.5	28.4

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17601, 4.36 per cent.

MORTON CLAY.

The soil of the Morton clay is a brown clay or silty clay ranging in depth from 6 to 15 inches. The subsoil is a heavy silty clay of gray to brown color, usually passing into drab shaly clay at less than 40 inches. The surface soil puddles when wet and when dry is intersected with cracks. The soil is naturally impervious and difficult to till.

The Morton clay is an unimportant type, being confined to a few small areas of sufficient size to indicate on the map, which accompanies this report; but numerous small patches from a few rods in diameter up to 5 acres occur throughout the areas of Morton loam. It usually occupies small knolls and hillsides where rapid erosion has exposed the shales. This soil is the heaviest member of the Morton series and is derived by weathering from the beds of fine shales which occur throughout the Laramie formation in this region. It is a product of the imperfect weathering of these shales, and the partially decomposed rock not yet converted into soil is usually found at no great depth. As a result of the decomposition of the shales, which in nearly all cases contain more alkali than the sandstones, and the impervious nature of the resulting soil, which has retarded the rapid removal of alkali from the soil, areas of this type nearly always show indications of injurious soluble salts. To such an extent have these salts accumulated at the surface that the grass is often sparse on these areas, and spots several feet in diameter are bare, when a luxuriant growth of grass should be found on a soil so well suited by texture to short-rooted plants. These accumulations of alkali, however, are not so great as to be detrimental to cultivated crops, for in most instances when the land is plowed and the surface accumulation of salt is mixed to a depth of several inches, there will not be further trouble on account of alkali.

None of the small areas of Morton clay are at the present time under such conditions of cultivation as to indicate the agricultural possibilities of the type. By texture, however, the soil is well adapted to grasses and the cultivated varieties, such, for instance, as timothy, should do well. It is well suited to wheat and flax, which no doubt for a long time will be the principal crops on all types of soil in the area.

The following analyses show the texture of samples of the Morton clay:

Mechanical analyses of Morton clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17503.....	Soil.....	0.0	0.9	0.5	4.2	3.0	48.9	42.0
17504.....	Subsoil.....	.3	.7	.3	3.4	4.4	47.9	42.7

MORTON STONY LOAM.

The term Morton stony loam refers more to the stony condition of the surface soil than to the texture of the finer earth composing the true soil, and it is applied to areas which contain in the soil or have scattered over the surface such quantities of stone fragments as to make them unsuitable as farming land. The quantity of stone varies greatly in different localities, but from 15 to 50 per cent is commonly

found. The stone may consist of sandstone, chert, or glacial boulders. On the higher hills the sandstone and sandy shales, where exposed by rapid erosion, break down and the more resistant portions remain as fragments scattered over the surface or embedded in the soil. By far the greater part of the stone is chert, which was originally embedded in the parent rock, but in the general down-wearing of the country it has been left on the surface in the form of more or less rounded boulders, which range in size from small gravel to masses weighing many hundreds of pounds. The quantity of chert present in any one locality is dependent upon the quantity contained in the original rock and the extent of the subsequent erosion which has set free the cherty bodies. Another source of the stone content, which is comparatively of small importance over the Morton area, is the glacial drift. Hills covered by glacial boulders may be seen in the north-eastern corner of the area, north of Wade. As a rule these deposits are of limited extent on the tops of the higher hills, and consist of smooth boulders and gravel from the smallest size to a foot or more in diameter. Occasionally on these hills and scattered over part of the area are large boulders of granite and other igneous rocks, several feet in diameter and weighing many tons.

The interstitial soil material in these stony tracts may vary widely in texture. In view of the undesirability of these lands for cultivation, it was not considered advisable to subdivide these areas on the basis of texture. As a general rule the stony land is of a sandy nature, and disregarding the stone content it much resembles the Morton fine sandy loam. This is nearly always the case where the stone consists of sandstone. There are, however, areas where the fine earth ranges from a silty loam to a heavy loam, and this is more likely to be the case among the chert boulders.

The Morton stony loam occurs in irregular areas over the entire region. There are very few square miles entirely free from these stony tracts, many of which are too small to be indicated in a map of the scale used. Large areas of extremely stony land may be expected among deeply eroded hills. The most remarkable development of the chert-covered hills may be seen in Pretty Rock Buttes and some of the hills in the vicinity. Here the intervening areas are so thickly strewn with masses of chert fragments that it is difficult to set foot without touching a stone.

The stony land is not uniform in character, and narrow winding valleys of tillable land occur throughout the rocky hills. It was not possible to outline these valleys on a small scale, but in many cases they furnish room for a house and small fields for those who occupy the hills in order to graze their cattle and thereby greatly enhance the value of the rough land. Such tracts may be utilized to raise winter feed for the cattle and supplies of potatoes and vegetables for the use of the rancher.

WADE FINE SANDY LOAM.

The Wade fine sandy loam to a depth of 36 inches is a fine sandy loam with no marked variation in texture between soil and subsoil. The surface 8 inches, however, is usually darker in color, due to its larger content of humus. As in the case of the other alluvial soils in the Morton area, there is no uniformity in the texture of the Wade fine sandy loam over any considerable areas, even in the same stream bottom. Thin beds of heavier and lighter material may alternate throughout a 3-foot section, but the general average of texture for this type of soil is that of a fine sandy loam. On some of the higher terraces the soil closely resembles the Morton fine sandy loam, and where the two types are contiguous it is often difficult to determine their boundary lines.

The Wade fine sandy loam is the most sandy member of the soil series found along the streams of the Morton area. It borders the Cannon Ball River in broken strips and with frequent variations in texture, the most sandy tracts occurring in the lowest levels in the southeastern part of the area. The type occurs along some of the small streams. Timber Creek, in the western part of the area, is bordered by the largest bodies.

The lower flood plains of the Cannon Ball are subject to occasional overflow, but the flood waters quickly subside and none of the type lacks drainage.

The Wade fine sandy loam is derived from the sediments deposited by the streams in times of overflow. The streams gather their sediments from the upland soils of the Morton series, and the assorting action of the stream currents have separated the different grades of sand, silt, and clay, and deposited them as soils in their present positions.

A large part of the Wade fine sandy loam is now under cultivation. Oats, flax, millet, and corn, and to a lesser extent wheat, are grown with profitable results. The lower terraces will produce good crops in seasons when crops on the uplands suffer for lack of rain. The type is well adapted to alfalfa, but so far it has not been tried. Heretofore the most successful and most profitable crop has been oats. All kinds of vegetables and truck may be produced in large quantities when there shall arise a demand for such products. At present they are grown by the ranchers for home use.

The following analysis shows the textural composition of the Wade fine sandy loam:

Mechanical analysis of Wade fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16983.....	Soil.....	0.0	0.9	3.5	42.0	20.1	24.2	8.5

WADE LOAM.

The Wade loam is, after the Wade fine sandy loam, the most extensive of the alluvial soils of the area. Like the Wade fine sandy loam, it is not uniform over any considerable areas. The average texture of the type is a loam of high silt content with a depth of 8 inches. In color it ranges from a light to a dark brown in the case of the soil, with a subsoil of lighter color.

The Wade loam is found in narrow strips along Cannon Ball River and many of the smaller streams, and has a total area of 8,576 acres. It usually occupies the lower terraces of the streams, many of them subject to overflow, but in some cases the type occurs on older terraces now above the limit of flooding. As a rule, the flats or bottoms covered by the Wade loam are either level or very gently rolling, but drainage is nearly always adequate for farming purposes. Wherever conditions are favorable there are accumulations of alkali salts in the lower flats.

The Wade loam is the most desirable of the alluvial soils from an agricultural standpoint. The soil is retentive of moisture and advantageously situated for purposes of general farming and especially well located for stock raising. Wheat, flax, and oats are the principal crops, with some corn and millet grown for feeding purposes. The soil is also adapted to alfalfa where the drainage is good.

The following table gives the results of mechanical analyses of a sample of the soil and subsoil of the Wade loam:

Mechanical analyses of Wade loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17606.....	Soil.....	0.1	2.5	2.0	17.4	8.0	52.8	17.7
17607.....	Subsoil.....	.3	5.0	4.9	27.6	14.0	36.1	12.2

The following sample contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17607, 1.91 per cent.

WADE CLAY.

The Wade clay is the heaviest alluvial soil of the area. It consists of a brown to nearly black clay to an average depth of about 6 inches, underlain by a brown to dark-drab heavy clay to a depth of more than 36 inches. The large percentage of organic matter imparts the dark color to the soil.

The term Wade clay has been made to include the clays deposited along the streams and the soils which have been deposited in depressions in the upland, many of which are now parts of stream valleys but at a former time were low areas without well-established drainage. This soil is usually washed from the clay or shale areas of the upland, and in many cases comes in contact with the Morton

clay and resembles it so closely that the only basis of separation is one of origin.

None of the Wade clay is yet in cultivation, but it is a productive soil, and aside from the difficulties of tillage it should be very desirable farming land. The small areas of the type make excellent hay meadows, and hay has been mowed from them by the cattlemen for a long time.

The table given below shows the texture of the Wade clay:

Mechanical analyses of Wade clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17589.....	Soil.....	0.0	0.9	2.2	7.0	11.0	42.4	36.7
17590.....	Subsoil.	.0	.4	1.8	4.4	7.0	60.9	25.2

MORTON GUMBO.

The Morton gumbo represents a condition rather than a definite soil type. Mention has been made of the lignite strata that occur through the Laramie and the carbonaceous alkali shales which are associated with the lignite beds. The outcropping and subsequent weathering of these materials have given a condition typical of the entire Morton series over the southwestern part of North Dakota.

The actual soil texture may vary, but the appearance and agricultural value of all of these areas of Morton gumbo is the same. In general, the surface soil is a gray silty loam to an average depth of 6 inches. The subsoil is a gray loam of lighter color and larger silt content. In some areas of this type, however, the lignitic beds may underlie the surface at a depth less than 3 feet. In very few cases can perfect lignite be found over such areas, but very often the black carbonaceous strata are encountered. The surface soil is, as a rule, heavier than at a depth of a few inches, but the puddling of the clay on the surface gives the appearance of a much heavier soil than really exists below the surface crust. All areas of the soil are extremely silty, there being in most cases 50 to 60 per cent of silt in the soil, and 60 to 65 per cent in the subsoil. The clay in both soil and subsoil ranges from 20 to 30 per cent.

The characteristic feature of the Morton gumbo is its present unproductiveness, due to the large amount of injurious alkali salts in the soil. The term "gumbo" is used by the average farmer to designate any spot which is unproductive by reason of alkali. The farmer has learned by experience that unproductiveness is associated with a heavier soil; hence land containing spots of loam or clay with sparse vegetation is avoided.

The Morton gumbo occurs in detached bodies of various sizes throughout the area. Where the carboniferous shales outcrop upon a broad, flat valley, or immediately underlie the surface, stretches of the type of several square miles in extent may result. Frequently the soil occurs as strips along the streams where erosion has exposed the shale. Over a large part of the area small spots of it may occur in cultivated fields, causing much annoyance to the farmer.

The type is not confined to any particular topography. It occurs on sloping hillsides and over level flats. The surface features and vegetation are characteristic. The unproductiveness does not extend over the whole of the areas, but occurs in spots with narrow strips of good land between. Where the spots are so infrequent as not seriously to impair the agricultural value of the land, the areas have been included with other types, and only those areas have been indicated on the map as Morton gumbo that are of large size and so unproductive as to be of little value for farming. Another characteristic of the type is the roughness of the land, due to the settling of the ground or, on slopes, to landslides. The vegetation is also characteristic, consisting, in the alkali spots which are not entirely bare, of cactus, sagebrush, and other salt-resisting plants. The spots entirely bare rarely exceed a few feet in diameter, except where the lignite beds outcrop. The strips free from injurious salts support a growth of good pasture grasses, so that nearly all of the "gumbo" flats have value as grazing land.

One phase of the land mapped as Morton gumbo deserves mention. Along Cannon Ball River and some of the smaller streams strips of the type as mapped are not entirely of residual origin, but are wholly or in part the washings from the "gumbo" areas on the hillsides. As this phase nearly always comes in contact with the typical "gumbo," and as there is no great difference in the two, it was not considered practicable to separate them.

Any analysis, chemical or physical, of the Morton gumbo, can show very little, owing to its variations, but the table given below shows the texture of a sample of the type:

Mechanical analyses of Morton gumbo.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17006.....	Soil.....	0.0	0.3	0.8	13.3	3.6	60.3	22.0
17007.....	Subsoil.....	.0	.4	1.6	5.5	.6	60.5	32.1
17008.....	Lower subsoil...	.0	.3	1.1	7.1	1.7	66.0	23.6

ROUGH BROKEN LAND (BAD LANDS).

Throughout the western part of North Dakota, where the bed rock is chiefly the sandstone of the Laramie formation and where these rocks have been subject to rapid erosion by the streams, a typical

topography has been developed. On account of the extreme roughness of these tracts and the difficulty of crossing them, they were called by the early French explorers "Bad Lands to Travel Through," which has since been shortened to "Bad Lands," by which name they are now generally known. Although the Morton area is far to the east of the Bad Lands proper, small areas of badly eroded hills occur, to which the name has been applied.

The Bad Lands are sharp rugged hills, sometimes devoid of vegetation but more often partly grassed over. Many of the hills have the butte or mesa form—a flat top covered with grass and steep sides commonly bare. Many slopes are extremely rough and cut by numerous gullies and ravines. Narrow, winding, level valleys may occur throughout the Bad Lands, covered with good grasses or so affected with alkali as to support no valuable vegetation.

The extent of Bad Lands in the Morton area is only a few square miles, the largest area lying west of Wade. The narrow strips in the other parts of the area indicate the line of steeply eroded, rough, bare bluffs that mark the descent from the upland to valleys below.

The Rough broken land is by no means without agricultural value, for it has always been highly esteemed as a grazing ground by the cattlemen. Water and good grass are to be found here and the high bluffs afford protection from winter storms. At the present time these lands have an additional value for the rancher who depends entirely upon grazing, for in the Bad Lands he will never be disturbed by the homesteader.

SUMMARY.

The Morton area is situated in the southern part of North Dakota and west of the center of the State. It lies wholly within the drainage basin of the Cannon Ball River. The region as a whole is a high plateau, the surface of which ranges from gently rolling to rough and hilly.

Until within the last two years the only settlers were occasional ranchers who grazed horses and cattle on the public lands, but there has recently been a rapid immigration, so that now all public land suitable for farming has been taken for homesteads, though there are as yet no towns or railroads.

The climate of this part of North Dakota is subject to high summer and low winter temperatures. The atmosphere is dry and healthful. The snowfall is usually light and cattle graze over the hills throughout the winter. An average of about one hundred and twenty days each year free from frost gives a growing season of sufficient length for the maturity of the common crops of this region.

The question of rainfall is one of great importance to this area. The average rainfall is sufficient, if well distributed throughout the growing season, to produce good crops. Occasional dry years may be expected, but with proper care and the practice of the best methods

of dry farming there is no reason why the farmer in this area should not be entirely successful.

The conditions prevailing in the Morton area are those of a newly settled country, and not much advancement has yet been made in agriculture. Sod crops of wheat, flax, and oats were put in by the settlers and the results have been encouraging. All hay, oats, and potatoes produced have found a ready local market. Cattle and horses are still raised in large numbers by the ranchers and many large flocks of sheep are found in the area.

The soils of the Morton area fall into two principal series—the Morton series, the soils of which have been derived by weathering from the sandstones and shales of the Laramie formation, and the Wade series, which consists of the same soils reworked and redeposited by stream action. The most important soil of the upland Morton series is the Morton loam, which comprises the greater part of the safe farming land of the area. It is very productive, retentive of moisture, and easily tilled. In average seasons it produces large crops of wheat, flax, and oats. The Morton fine sandy loam, while not so retentive of moisture as the Morton loam, is over a large part of the area a good farming soil and for many years it has produced a good average of profitable crops. The stony areas of the upland have been classed without regard to texture as Morton stony loam. It furnishes excellent grazing.

The soils of the Wade series, with the exception of the Wade silt loam, occur in narrow strips along the larger streams.

The Wade silt loam occurs in broad valleys in the upland, and its texture and humus content make it one of the most desirable soils of the area. The alluvial lands along the streams range in texture from very sandy loams to heavy clays, but only the Wade fine sandy loam and the Wade loam are of agricultural importance. The soils are adapted to a wide range of crops, but at present wheat, flax, and oats are grown.

The Morton gumbo occupies considerable areas in both the upland and in the stream valleys. It occurs on the outcropping of the lignite beds and the alkaline shales with which they are associated. This soil is difficult to till, but the greater part of it may be used for pasture. The Rough broken land (Bad lands) is a badly eroded country that has no value except for grazing, to which it is well adapted. There is only a very small proportion of the Morton area that is without some agricultural value, and the greater part of it is good farming land. The mixed farming and grazing land make this region especially suited to stock raising in connection with farming, and this mixed agriculture will in the end be found more profitable than the growing of farm crops exclusively.

SOIL SURVEY OF THE M'KENZIE AREA, NORTH DAKOTA.

By A. E. KOCHER, assisted by R. P. STEVENS, of the Agricultural and Economic Geological Survey of North Dakota.

DESCRIPTION OF THE AREA.

The McKenzie area, comprising ten townships in the southwest corner of McKenzie County, is located in the extreme western part of North Dakota, equidistant from the north and south boundaries of the State. It is bounded on the north by township line 143 N. and east by range line 103 W.; on the south by Billings County, and on the west by the State of Montana. It is included between the meridians of $103^{\circ} 44'$ and $104^{\circ} 2'$ west longitude and the parallels of $47^{\circ} 19'$ and $47^{\circ} 39' 30''$ north latitude and has an area of 222,784 acres, or about 348 square miles.

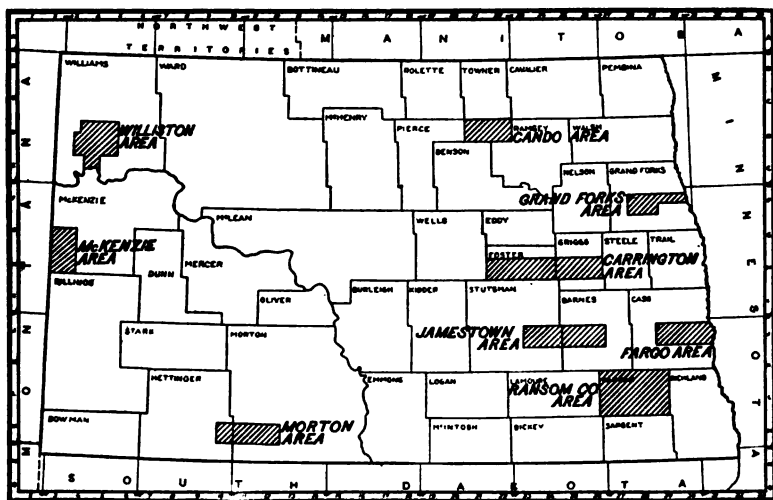


FIG. 29.—Sketch map showing location of the McKenzie area, North Dakota.

Through most of the region the surface features are extremely rough and broken. Within 2 miles of the southeast corner of the area flows the Little Missouri River, a stream widely known for the treachery of its channel and the extensive devastation wrought by its rapidly eroding tributaries. Because of the peculiar desolation of the tract along this stream the lands are known throughout the West as "Bad Lands," and though highly prized as a winter range for stock they are entirely unfit for cultivation.

The drainage of the region is exceptionally good. The divide between the Yellowstone and Little Missouri rivers passes in a northeasterly direction across the southeast corner of the area, from which

it will be seen the waters move chiefly westward to the Yellowstone. This river has a general northeasterly course and lies about 20 miles from the southwest corner and about 6 miles from the northwest corner of the area.

Though many stream courses are indicated on the map, none of them carry water except in the late fall and spring. The largest and most important of these streams is Bennie Pierre Creek, which, beginning near the southern line, winds in a northerly and westerly course to the northwest corner of the area. Entering this stream from the west and south are many smaller ones, which completely drain the central part of the area. Of these, Spring and One-Hundred-and-One creeks are the most important. From the north also flow several streams, the largest of which is Sheep Creek. Along these occur level productive valleys, which furnish the most desirable agricultural lands surveyed. A second divide, running east and west, occurs just south of the northern line of the area. Beyond this divide are several well-developed channels of drainage that also eventually reach Yellowstone River. Of these Shabeneau and Horse creeks are the largest and most important. In the southwest corner of the area Smith, the North Fork of Smith, and Poison Springs creeks provide excellent drainage. Flowing east into the Little Missouri River are a number of deeply cut streams, whose steep-sided laterals, branching and rebranching, have pushed back into the prairie and converted the region through which they pass into an intricate network of gullies and ridges. The largest of these dry waterways is Prairie Dog Creek—noted for the wide extent of rugged Bad Lands along its course. A peculiar feature of the drainage of the region is the occurrence of numerous “draws” or “gaps” connecting one drainage system with another. The most marked of these is “Hay Draw,” a wide, level valley whose fall is so slight that for some distance on its crest the water at times takes a westerly course to the Yellowstone and at other times flows eastward to the Little Missouri. Other “draws” of this nature are Squaw Gap, Shadwell Gap, and one in the northwest corner of T. 146 N., R. 103 W., connecting Spring Creek with Bennie Pierre Creek.

Most of the people in the McKenzie area are ranchmen of considerable experience, having come to this region from the Black Hills country in South Dakota, where for years their stock enjoyed unlimited range.

The agricultural development of the McKenzie area has been greatly retarded by the absence of transportation facilities. The nearest shipping point to the south is Wibaux, Mont., on the Northern Pacific Railroad, 33 miles away. To the north the nearest shipping point is Williston, on the Great Northern Railway, 35 miles from the northern boundary line. Except one road to Wibaux no established roads lead from the area to either of these points. Thus it will be seen

that parts of the area are 50 miles from any shipping point. As yet no roads have been laid out, although well-established trails connect the various ranches. The region is very sparsely settled; only 12 ranches occurring within the area mapped. No agriculture is practiced, the people devoting their entire time to the stock-raising industry. This is due in part to the lack of transportation facilities and in part to the marked adaptability of the region to this special industry. About 9 miles to the west of the northern part of the area is the growing town of Sidney, Mont., but having no facilities for transportation it is of little use in disposing of the products of the area. All of the cattle raised are driven to Wibaux, Mont., or to Williston, and from these points shipped to Chicago.

CLIMATE.

In the study of conditions affecting agricultural development no factor is of greater importance than that of climate. This is especially true in a region where rainfall is uncertain and where killing frosts are apt to come during the period of crop growth. The McKenzie area is located in that part of the great central plain known as the semiarid belt. Throughout this region rainfall is so scant or so unevenly distributed that without irrigation, except in unusual years, successful crop production is possible only by the practice of systematic methods of intensive cultivation. Now and then a year is had when rainfall, if carefully conserved, is ample for crop production, but in the past such years have been the exception rather than the rule.

No climatic records have been kept within the limits of the McKenzie area, nor at any station where climatic conditions are precisely the same. At Williston, 35 miles north of the area, and at Oakdale, across the Little Missouri River, 40 miles east of the area, records have been kept, but at the latter point the rainfall is slightly increased and the temperature somewhat modified by the presence of the Killdeer Mountains. By reference to the data in the accompanying table, compiled from the records of the United States Weather Bureau at Williston, it will be seen that the average yearly rainfall at that place is 15.6 inches. This, it will be observed, is so distributed that over 50 per cent of the total amount falls during the three growing months of May, June, and July. It will also be seen that for these three months during the driest year only 3 inches of rainfall was had. During the wettest year 13.7 inches is recorded for these three months, which, if properly handled, is quite sufficient for the production of crops. But it should be noted, too, that for this wet year the total precipitation for the four months preceding May was only 1.5 inches. By comparing these conditions with those which prevail in the eastern part of the State it will readily be seen that the degree of success attending the efforts of the farmer in the east can not be hoped for in the McKenzie area, unless more intensive methods of

cultivation are resorted to. From a study of the tables it would seem that climatic conditions at Oakdale are somewhat more favorable for agricultural operations than are those reported at the Williston station. Here the rainfall for the driest year was 15 inches, about 50 per cent of which was well distributed throughout the growing season. The mean temperature throughout the year is slightly higher than at Williston, though this increase is all recorded for the winter months, the growing season being somewhat cooler. At Williston temperatures of 100° F. or more are recorded for May, June, July, August, and September, while at Oakdale the temperature has reached 100° F. only during July and August. The lowest temperature recorded at Williston is -49° and at Oakdale -41° F.

The average date of the last killing frost in spring, as recorded at the Oakdale station, is May 2, and of the first in the fall September 15, giving an average growing season of 136 days. At Williston the average date of the last killing frost in the spring is May 18, and of the first in the fall September 14, which gives an average growing season of 119 days. The latter figures probably closely represent the average conditions in the McKenzie area, although during the present year (1907) a killing frost occurred on August 2.

The annual snowfall of the region is rather heavy, the average being 39.6 inches at Williston and 43 inches at Oakdale. This interferes to a great extent with winter grazing, except in the rough broken land. Here the snow is blown away, leaving sufficient vegetation to supply the herds of horses and mature cattle which are allowed to graze.

The following tables give the normal monthly and annual temperature and precipitation, the absolute maximum and minimum temperatures, the snowfall, and the amount of precipitation for the driest and wettest years for the two stations mentioned above:

Maximum, minimum, and normal monthly and annual temperature.

Month.	Williston.			Oakdale.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Absolute maximum.	Absolute minimum.
	°F.	°F.	°F.	°F.	°F.	°F.
January	6	52	-49	16	59	-32
February	8	57	-46	13	56	-41
March	22	72	-35	28	66	-22
April	43	92	-4	44	87	16
May	55	101	11	55	92	20
June	63	137	30	62	98	31
July	69	106	37	68	101	40
August	67	107	34	66	100	36
September	56	100	17	56	93	24
October	44	95	-3	45	78	4
November	25	69	-29	26	72	-22
December	14	59	-46	21	56	-27
Year	39	107	-49	41	101	-41

Maximum, minimum, and normal monthly and annual precipitation.

Month.	Williston. ^a				Oakdale. ^b			
	Mean.	Total amount for driest year.	Total amount for wettest year.	Snow, average depth.	Mean.	Total amount for driest year.	Total amount for wettest year.	Snow, average depth.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
January	0.6	0.1	0.1	6.6	0.4	0.7	1.4	3.9
February	.5	.1	.5	5.4	.7	1.4	.6	7.6
March	.7	.1	.2	6.8	1.6	1.8	.4	13.4
April	1.3	1.3	.7	4.0	1.3	1.6	.6	5.1
May	2.1	.1	4.0	1.6	3.2	.7	7.8	.6
June	3.6	1.0	5.5	.0	4.1	2.6	2.3	Trace.
July	2.2	1.9	4.2	.0	2.1	1.4	4.6	.0
August	1.7	1.1	2.4	.0	1.3	2.5	4.0	.0
September	.8	.5	1.0	Trace.	1.2	.3	1.9	Trace.
October	.9	.5	.9	2.2	.6	.4	.4	2.1
November	.6	.3	.7	6.9	.8	.9	.4	7.4
December	.6	.4	3.1	6.1	.6	.7	1.6	2.9
Year	15.6	7.4	23.3	39.6	17.9	15.0	26.0	43.0

^a Average date of last killing frost in spring, May 18; first in the fall, September 14.

^b Average date of last killing frost in spring, May 2; first in the fall, September 15.

AGRICULTURE.

As yet no attempt has been made to introduce agriculture into the McKenzie area. Here and there a small garden is planted to vegetables for home consumption, but the total acreage under cultivation does not exceed 20 acres. To the south 15 or 20 miles, where transportation facilities are not so distant, a few scattering homesteads have been taken up within the last five years, and the growing of small grains is being introduced. On the west no agriculture is found until the valley of the Yellowstone is reached, where the irrigation ditch being constructed by the United States Government is having marked effect in stimulating agricultural development. From the north during the last two years settlers have been gradually pushing south, a few having nearly reached the northern limits of the area surveyed. On the east side of the area the rough broken lands along the Little Missouri soon begin and continue for several miles beyond the river, thus effectively checking the advance of homestead settlements from this direction.

The leading industry practiced in the McKenzie area is the live-stock industry. Diseases which so commonly affect the stock in latitudes farther south are here unknown, and cattle, horses, and sheep are raised at nominal cost. In the early years of ranching little attention was given to the care of the stock, but lately it has been found that a supply of hay during the winter months is an excellent insurance against loss. Only the weaker animals, however, ever need to

be fed, the larger part of the herds getting their subsistence unaided. During the winter, when the main body of the herd is allowed to run uncared for on the plains, the animals become widely scattered and sometimes drift for many miles from the owner's range. About May 1 the general round-up is begun, when all the cattle are collected and driven back to their respective ranges. Here the calves are corralled and marked with the owner's brand, after which they are again returned to the herd and allowed free range upon the plains. About the middle of July, soon after the general round-up is completed, the haying season begins and continues until the gathering of the beef herd takes the men from the field. This is usually about September 20. At this time little attention is given to the stock other than that intended for shipment, which usually includes no animals less than 4 years old. During the late fall months, before winter sets in, the range is gone over again and all the calves and the less vigorous animals, which, if uncared for, would be apt to succumb during a period of deep snow, are collected and driven to the home ranch or where stacks of hay have been provided for winter feeding. Here they are cared for during the hardest winter months, the hay being hauled and scattered on some convenient feeding ground at the rate of 1 ton per day for every 100 head. As the period of actual feeding never exceeds 100 days, 1 ton of hay is considered amply sufficient for each animal intended to be fed.

When horses are kept no provision is made for their maintenance during the winter months. The areas of rough broken land are largely their range, as here the snow blows away, leaving the vegetation bare, while the numerous deep ditches with precipitous walls closely encircled by steep-sided hills provide an excellent shelter from the winter winds and storms.

Those who keep sheep are usually prepared for the severities of the winter. Good warm sheds are provided, and if the snow becomes too deep or the weather unusually bad hay is hauled and fed near these at the rate of about 2 tons per day for every 1,000 head of sheep. If, on the other hand, the winter be open and the ground sufficiently free from snow, no hay is required; the sheep are turned out on the range and herded on the spots where the snow has blown away, being returned to the sheds only at night or on unusually bad days. Thus it is seen that the duties of the ranchmen require help the year around. As a rule, the labor secured is reliable and efficient. The busiest season, when help is hardest to obtain, is in the early spring months and in the summer, when the hay is being cut. At these times the wage paid ranges from \$45 to \$65 a month. During the winter months, when the work is light and fewer men are needed, sufficient help can be secured for \$45 a month. Owing to the trying solitude of a sheep

herder's life, his services command a relatively higher price, this work rarely being done for less than \$65 a month.

Throughout the region are found extensive deposits of valuable lignite coal. In the mapping of the area no effort was made to indicate the localities in which the material appeared, although there were many places in which the veins were prominently exposed. From the frequency with which these exposures occur it will be seen that fuel, even though the region be treeless, is abundant. The importance of this for home consumption in a section so far removed from railroads can hardly be overestimated.

The McKenzie area, though primarily a grazing district, is capable of considerable development in an agricultural way. Through the area run a number of broad, level bottoms whose drainage channels, though dry during the greater part of the year, carry immense volumes of snow water during the early spring thaws. This water, if utilized, would be one of the most valuable assets the area possesses. By its use the valleys could be made to produce large quantities of alfalfa hay—a crop which would be especially valuable in this region. Small grains could also be produced, but under the present conditions of transportation these crops would not prove so profitable as would one which could be fed directly from the field and from which much of the cost of expensive marketing is eliminated. Though the region is somewhat arid for the best results on the upland soils, it is probable that with thorough cultivation fair yields could be secured. As the soils receive but little rainfall after the crops are planted, the question of conserving soil moisture at the time of plowing is a very important one. On account of the dryness of the climate and the roughness of the topography, the area as a whole is better fitted for grazing purposes than for the growing of cultivated crops, and for this reason haste should not be made to destroy by uncertain cultivation the nutritious prairie grasses, which now dominate the uplands and which are of such inestimable worth to the live-stock industry.

SOILS.

The geographic position of the McKenzie area in the semiarid belt, as well as its geologic position on the lower line of glaciation, has a marked effect on the character of the various soil materials. In the southern part of the area the soils are largely the residual ones of the western prairie regions, while in the northern part they partake both of the nature of this soil province and also of the glacial province. As is common throughout the western prairie regions, the soils possess a high percentage of silt, but the content of organic matter is here somewhat less than is usually found in prairie soils

and the color is considerably lighter. No large bodies of any one type occur in any part of the area—a condition due to some extent to the active erosion which has taken place.

In a general way the soils may be divided into two general groups—the upland or residual soils and the lowland or alluvial soils. Of the former there are six distinct types and of the latter two. As the area occupies the divide between the Yellowstone and Little Missouri rivers, portions of it are very rough and rugged. In the southeast corner, where the divide is most pronounced and where the deeply cut streams have worked their way up from opposite sides nearly to the summits of the hills, this condition exists to a very marked degree. In such places, which are locally known as Bad Lands, the soils occur so badly mixed that detailed classification is impracticable and they have been indicated in the map under the general name of Rough broken land. Farther down the streams, where the channels are older and better established, the valleys widen out and give rise to the two alluvial soils—the Wade silt loam and the Wade clay. These soils are composed chiefly of the materials washed down from the Rough broken land and constitute the most valuable soils in the area. On the uplands the most common type is Morton silt loam—a soil of distinctive texture formed by the weathering of fine-grained sandstone. Other types formed from this material are the Morton fine sand and Morton fine sandy loam. Their occurrence, however, is not extensive.

The most prominent feature of the area is the presence of high, red ridges of Scoria gravel. This shale-like material is found in all parts of the area, and aside from its deposits of lignite coal is valuable only as pasture for stock. Its formation is due to the weathering of materials formed by the heat of burning coal beds. Morton stony loam is the most limited soil in the area and is the only one in which the effects of glaciation are apparent. The gravel is only a thin glacial covering overlying the materials of the adjacent soils and is not found in the area south of the northern tier of sections in T. 146 N., R. 104 W. This location is of interest in that it marks for this region the lower line of glaciation.

To the north and east of this line an impervious clay loam soil occupies the greater part of the area. This soil is notable for the frequent occurrence of small, depressed areas on which the vegetation has been destroyed either by the sliding of the water-soaked soil or by the burning action of alkali. In this respect the type resembles the Carrington clay loam of the Carrington area. The two differ, however, in that the Carrington clay loam is a glacial-formed soil, while the Morton clay loam is residual.

The table following gives the names of the several soils and the area which each covers.

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Morton silt loam.....	104,576	46.9	Morton clay loam.....	15,872	7.1
Scoria gravel.....	25,920	11.7	Wade clay.....	7,680	3.4
Wade silt loam.....	25,216	11.3	Morton fine sand.....	3,072	1.4
Morton fine sandy loam.....	21,568	9.7	Morton stony loam.....	896	.4
Rough broken land (Bad lands).....	17,984	8.1	Total.....	222,784	-----

MORTON SILT LOAM.

The soil of the Morton silt loam consists of 6 to 10 inches of gray or yellowish-brown friable silt loam. The subsoil, to a depth of 2 feet, is a yellowish-gray silt loam or silty clay, beneath which occurs a compact silty clay of a somewhat lighter color. On account of the accumulation of organic matter in the surface foot, the structure of the soil when dry is fairly loose and open, making it a comparatively easy soil to cultivate.

On the level or gently rolling areas, where drainage is good, the friable yellowish-gray material extends to a considerable depth, but where the type is in the vicinity of the Rough broken land or where the drainage is poor the yellow color soon disappears and the material becomes a sticky, compact clay having all the characteristics of gumbo. These areas, though numerous, are all so small in extent that none could be shown on the map as a separate type.

The Morton silt loam, by reason of its extensive acreage, is one of the most important soil types in the area surveyed. It is found in all parts of the area in both large and small bodies, though its most typical development is seen near the southwest corner between Smith Creek and the north branch of this stream. Other typical bodies are found along the sides of Spring Creek in T. 147 N., R. 104 W., and on each side of One-Hundred-and-One Creek in T. 147 N., R. 105 W. Here the type occurs in comparatively large bodies, broken to some extent by narrow valleys of Wade silt loam and irregular ridges of Scoria gravel.

The greater part of the Morton silt loam has a sloping or gently rolling topography. This is especially true of the type along the North Fork of Smith Creek and in nearly all of the western half of the area. As the soil when wet is more or less sticky and adhesive, the sloping topography, if not too steep, is a decided advantage, for it insures excellent surface drainage and would permit of early cultivation and seeding in the spring. In the eastern part of the area, where the type occurs in small bodies closely associated with the Rough broken land, the topographic features are so rough and rugged that any attempt at cultivation would likely prove a failure.

Throughout most of the region surveyed the Morton silt loam is a residual soil, being derived in place through weathering from fine-grained sandstone. On the sloping sides of valleys, however, where the descent is very gentle, the type is both residual and colluvial in formation. Here and there throughout the areas, small mounds and ridges are sometimes found capped by angular fragments of brownish-yellow flintlike rock, which, from their prominent position, give the type the appearance of having a more broken topography than it really possesses. Large sandstone concretions from 3 to 10 feet in diameter and from 50 to 100 feet in length are also frequently found on the higher elevations. Where these occur the soil is apt to contain a small amount of very fine sand and the topography is usually more or less broken.

Throughout the areas of this soil in the northwest part of the survey narrow ridges of fine glacial gravel are occasionally seen, but most of them are too small to appear on the map as a separate type.

As a rule, the Morton silt loam is fairly free from alkali; however, on the lower levels and in the vicinity of buttes, where the surface soil has been removed, a thin, white crust is sometimes seen, indicating that salts are present to some extent.

Throughout the area the soil is treeless, the vegetation being the native grasses common to the plains. When this is mowed the yield ranges from one-third ton to 1 ton per acre. None of the soil has ever been broken up for cultivation, and probably not more than 2 per cent of its total acreage is mowed for hay. The type is almost wholly used for grazing, for which it is well adapted. Of the upland soils this is the most suitable for agricultural purposes, and with thorough tillage and favorable seasons a fair degree of success would doubtless result from its cultivation. Small grains, hay, and potatoes should do well on this type if sufficient rainfall is had. On account of its higher position and consequent greater freedom from frosts the soil is the best in the area for the production of corn, but only in exceptional years could this crop be matured before the appearance of frosts.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Morton silt loam:

Mechanical analyses of Morton silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17032, 17660-----	Soil-----	0.4	3.0	2.1	6.5	8.3	66.3	13.0
17033, 17661-----	Subsoil-----	.1	.6	.2	1.2	4.9	78.5	13.4

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17032, 14.38 per cent; No. 17033, 24.60 per cent; No. 17660, 30.87 per cent; No. 17661, 20.75 per cent.

WADE SILT LOAM.

The Wade silt loam consists of 6 to 10 inches of dark-brown to black silt loam containing a high percentage of organic matter. The subsoil is usually a light-brown or brownish-yellow silt loam or silty clay similar in appearance to that of the Morton silt loam. When dry, both soil and subsoil are fairly loose and open, making it a comparatively easy soil to cultivate. When wet, however, the high clay content renders it sticky and adhesive. In a few places, where the fine material of Morton silt loam has recently washed in and vegetation has not had time to recover its growth, the surface is much lighter in color, sometimes presenting an ashy appearance, similar to that of the upland silt loam. Such areas are found in the western part of T. 147 N., R. 103 W., and in T. 147 N., R. 104 W., in the lowlands along Bennie Pierre Creek.

The Wade silt loam, though of small extent, is one of the best and most important soils in the area. It is seen only in the valleys of streams or dry waterways and in the narrow gaps which are sometimes found separating hills of Scoria gravel. The chief bodies occur as long, narrow strips on the flats of Bennie Pierre, Spring, and One-Hundred-and-One creeks and along the sides of Hay Draw. Other important bodies are found on the forks of Smith Creek, O'Brian Creek, and in Judd, Squaw, and Shadwell gaps.

The surface of the Wade silt loam is quite level, having only a very gentle slope from the banks of the streams to the beginning of the highlands. Hence in the spring the waters from the melting snows do not run off at once, but remain on the ground for several days. Later in the season, when the upland soils are dry, the influence of the standing water can still be seen in the more moist condition of this soil.

In origin the soil is alluvial, being formed partly by the overflow of streams in spring and partly by the wash of materials from the higher lying soils.

In the southern part of the area, along the forks of Smith Creek, alkali spots are frequently found, and where they occur vegetation is very scant and sometimes entirely lacking. These spots are all small in extent—usually not more than 3 or 4 rods across—but in the aggregate they occupy a considerable area of the soil in this vicinity. Farther to the north, along Bennie Pierre Creek, the soil does not seem to be seriously affected, although the water in the stream is strongly alkaline.

The type supports a luxuriant growth of rich native grasses, for which it is highly prized. Along the courses of Spring and Bennie Pierre creeks are found valuable trees of cottonwood, box elder, and

elm. These trees are usually rather small and short of trunk, except the cottonwoods, which occasionally reach the size of 3 feet or more in diameter. At the heads of valleys and here and there throughout the type are small areas densely covered by a low growth of wolf-berry brush (*Symphoricarpos occidentalis*). This growth, locally known as buckbrush, marks the location of the best soil in the area for general agricultural purposes; for in these positions the drainage is excellent and the black, moist soil extends to a depth of several feet. The areas, however, are usually small, rarely exceeding 40 acres in extent.

With proper handling the soil is well adapted to a wide variety of crops. Alfalfa, small grains, potatoes and turnips and other root crops should do well. None of this soil is under cultivation in the area, except a few small patches used principally for garden purposes. In these potatoes yield from 100 to 150 bushels per acre, and fair yields of wheat and oats are secured. About 5 per cent of the area of this soil is annually mowed for hay, the yield ranging from one-half ton to 1½ tons per acre, with an average yield of about 1 ton per acre. This small portion of the type yields about 90 per cent of all the hay cut in the area. The soil provides a large amount of excellent summer pasturage, but is considered too open for good winter range.

By utilizing the snow water in the spring this soil could doubtless be profitably irrigated. This could be done by throwing up embankments across the narrow places in the valleys, and after the water had been used to flood the soil above, it could be drawn off and utilized again to irrigate the valley below. In using water in this way, however, care should always be observed not to apply to the lower fields water that had become too salty as a result of flooding other fields.

The following table gives the average results of the mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Wade silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
17040, 17689.....	Soil.....	0.0	1.2	1.2	10.5	9.6	58.8	18.4
17041, 17670.....	Subsoil.....	Tr.	.8	.7	11.2	9.3	58.6	19.4

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17041, 2.43 per cent; No. 17670, 7.49 per cent.

WADE CLAY.

The Wade clay consists of about 6 inches of heavy clay loam or clay, varying in color from gray or light drab to black, resting on a

subsoil of stiff, heavy clay, with a somewhat lighter color than the soil. When dry the surface bakes exceedingly hard, and cracks 2 feet in depth and 1 inch or more across are not infrequent. Under the influence of water the soil becomes sticky and plastic, making it a difficult one to cultivate. From this fact the type is locally known as "gumbo," though it does not possess the waxy, tenacious property to the same degree as is found in gumbo of other areas.

About 12 square miles of Wade clay are found in the McKenzie area. The type occurs along the streams in narrow strips ranging from one-eighth to one-half mile in width. The principal bodies are found in the eastern part of the area, along Hay Draw, Bennie Pierre Creek, and the tributaries of this stream. Other lesser bodies occur in T. 145 N., R. 104 W., along the forks of Smith Creek, and in T. 146 N., R. 104 W., in the vicinity of Spring Creek. The areas have a level topography and are found only in the lowest parts of the draws and valleys. Because of this position the drainage is usually poor.

The origin of the soil is alluvial, the materials from which it is derived having been left by the waters of repeated overflows. On account of its low position and poor drainage, most of the soil is somewhat affected by alkali. This is evidenced by the numerous bare spots and the scant growth of grass which covers small areas here and there throughout the type. In the lowest places a few scattered trees of cottonwood, box elder, ash, and elm are occasionally seen, which adds considerably to the value of the type.

The Wade clay is naturally a strong soil. If properly drained and supplied with sufficient moisture, it would be well suited not only to the native wild grasses of the region, but to tame grasses, alfalfa, and small grains as well. Except in Hay Draw, the larger part of the areas of this type of soil is used only for pasture. Here the soil does not seem to contain much alkali, and a heavy growth of wild hay is produced each year. Nearly all of this draw is mowed for hay, the yield ranging from one-half ton to 1 ton per acre, with an average yield of about three-fourths ton.

Like the Wade silt loam, this soil would be much improved by irrigation. Although no water is available for this purpose, after the freshets in spring this could easily be accomplished by making use of the large volume of snow water. With proper subdrainage provided, one thorough flooding each spring would remove the greater part of the injurious salts and by supplying moisture well into the growing season would make the soil a highly productive one, whereas in its present condition its agricultural value is relatively low.

The following table gives the results of the mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Wade clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17088-----	Soil-----	0.0	0.1	0.2	2.6	1.8	52.1	42.8
17089-----	Subsoil-----	.0	.1	.2	3.4	2.3	51.1	42.2

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17088, 1.54 per cent; No. 17089, 2.72 per cent.

MORTON FINE SAND.

The soil of the Morton fine sand is a brown fine sand from 5 to 8 inches deep, usually containing a considerable quantity of organic matter. Below this depth the organic matter disappears and the material becomes a clean, gray fine sand, which overlies a gray silt loam from 3 to 5 feet deep. Both soil and subsoil have an open porous structure, though when thoroughly saturated with water the organic matter in the soil gives the surface a slightly compact appearance.

The Morton fine sand is not an extensive type in the McKenzie area, being found only in a few small bodies on the tops of hills and ridges. As a rule it is closely associated with areas of Morton fine sandy loam, into which it gradually merges with no distinct line of demarcation. The chief bodies occur in the eastern part of the area in T. 145 N., R. 103 W., and T. 147 N., R. 103 W.

Except where the areas occupy a plateaulike eminence, the topography is rolling. This, together with the open structure of the soil, is apt to give a too rapid removal of the rain water in the spring and cause the soil to suffer from drought during the drier, summer months.

The Morton fine sand is a residual soil formed by the weathering of fine-grained sandstone, exposures of which are of frequent occurrence throughout the type. In favorable seasons the soil supports a good growth of native grasses, but in dry years it suffers badly from drought and at such times the vegetation is scant.

None of the Morton fine sand is under cultivation in the area, nor is any of it mowed for hay. On account of the loose, open structure and the rapid drainage of the type it is one of the earliest soils, and for this reason is of value for spring pastures. Early in summer, however, the uncultivated soil dries out and the grasses cease to grow. If thoroughly tilled the soil should be adapted to potatoes, truck, and all garden crops, but is somewhat too light to be used successfully for continuous heavy cropping.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Morton fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17036.....	Soil.....	0.0	0.4	0.8	53.6	11.4	30.4	3.0
17037.....	Subsoil.....	.0	.7	.8	42.4	27.1	23.4	6.2

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17036, 1.91 per cent; No. 17037, 5.27 per cent.

MORTON FINE SANDY LOAM.

The soil of the Morton fine sandy loam consists of about 10 inches of brown fine sand or fine sandy loam. This is usually underlain by gray or light-brown fine sandy loam of a somewhat heavier texture. On the sides of hills and where the type is in close proximity to bodies of Morton silt loam, the subsoil is a gray or yellowish-brown silt loam, similar to that of the Morton silt loam. The structure of the surface soil is loose and open, rendering it an easy type to cultivate.

The Morton fine sandy loam is a common type in the McKenzie area, especially in the southern part. The most prominent bodies occur in T. 145 N., and R. 103 and 104 W., though minor areas are found in every township in the survey. The type occupies low swells and ridges in the prairie and has a moderately rolling topography. On account of this position, the soil is thoroughly drained and cultivation can be carried on almost immediately after heavy rains.

The Morton fine sandy loam is derived from the weathering of fine-grained sandstone, ledges of which are frequently seen capping the highest places throughout the type. This soil supports a good growth of native prairie grass, but owing to the abundance of more level hay land along the streams none of it is used for hay.

The type is treeless and open, and as it occupies a position exposed to the winds it is held in low esteem, except for summer grazing. However, in favorable seasons if properly cultivated this soil should produce a variety of crops. The good drainage and the high position give it a certain degree of freedom from frosts. Although as yet the production of corn has not been a success in this region, it is quite probable that in favorable years, with quick maturing varieties and thorough cultivation, gratifying yields could be secured. Potatoes should do especially well on this type, and all other crops that can be given thorough cultivation. Though fair yields of small grains could doubtless be produced, the soil is not so well adapted to these crops as are some of the heavier soils of the area. None of the Morton fine sandy loam is under cultivation.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Morton fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
17064, 17058-----	Soil-----	0.1	0.9	0.8	40.8	10.1	41.1	6.5
17085, 17650-----	Subsoil-----	.1	1.7	1.1	20.9	6.6	47.5	21.7

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17034, 0.69 per cent; No. 17035, 13.35 per cent; No. 17659, 7.76 per cent.

SCORIA GRAVEL.

Scoria gravel consists of bright red shalelike gravel from 6 to 10 inches deep. Below this depth the particles become coarser and more angular in shape, grading finally into solid rock at 2 to 3 feet below the surface. The small quantity of interstitial material found is usually a brown fine sand or fine sandy loam, although in places where the elevation of the area is not too high it consists chiefly of gray silt loam.

Scoria gravel is found in all parts of the McKenzie area, usually as long, narrow ridges or as a succession of steep-sided buttes. The chief bodies occur in the east and central parts of the area in Ts. 145 and 146 N., R. 103 W., and in T. 147 N., R. 103 W. Owing to the loose, open structure of the soil and the rough, broken topography, the rain-water is immediately borne away, so that in nearly every case the soil is excessively drained.

Scoria gravel is a residual soil probably formed through the agency of heat. Although more or less dispute is frequently heard as to the source of this great heat, it is highly probable that its immediate cause was the burning of vast fields of lignite coal. As the heat died out the molten mass solidified, taking a great variety of shapes. Under the influence of subsequent weathering, particles of the rock have chipped and broken off, till now the mass is little more than shalelike gravel, surrounding now and then a more resistant core of the solid rock. Because of the bright red color and the prominence of its position on the highest elevations the soil is one of the most conspicuous to be found in the West.

Magnetic iron is found to some extent in this material, though it is doubtful if the quantity is sufficient to make it of commercial interest. Lignite coal is also found, and its presence will in time add considerably to the value of the land.

On the higher elevations, where the material consists chiefly of gravel and the drainage is excessive, sagebrush and cactus share the ground with the scant growth of grass. Leading up into the hills,

however, from the streams and valleys are narrow, winding coulées,^a too limited to be mapped. These, receiving the drainage of the hills, produce a good growth of grass, and, being protected from the winter winds by the adjacent highlands, furnish a large amount of both summer and winter pasturage.

On account of the rough topography and the open gravelly structure of the soil, the Scoria gravel is of little value, aside from the pasturage which it affords.

MORTON CLAY LOAM.

The soil of the Morton clay loam is a brown loam or fine sandy loam from 0 to 6 inches deep. At an average depth of 4 inches the soil is underlain by stiff, heavy clay, ranging in color from dark gray or drab to black. When wet the subsoil becomes a dark slate color and is very sticky and plastic. As it dries small fissures are formed and the material becomes hard and impervious. This is especially noticeable where the surface materials have been washed away, leaving the clay exposed. Where this condition exists the type is locally known as "gumbo."

The chief bodies of Morton clay loam are found in the northeast part of the area in T. 148 N., R. 103 and R. 104 W. Other small bodies occur farther south, many of which are too limited to be shown in the map. The topography is level or gently sloping, the type usually occupying high plateaus and the upper part of hill slopes. The soil is also commonly found at the base of buttes and around the heads of some of the smaller streams. Except on the level areas the surface drainage is usually well established. The formation is chiefly residual, though in a few places the character of the soil is slightly affected by the presence of glacial gravel.

A peculiar feature of the soil is the frequent occurrence of small depressed areas, on which the surface materials appear to have been burned away, a condition similar to that found on the Carrington clay loam of the Carrington area. In some instances these areas represent merely "slides" of the water-soaked soil, but in others the vegetation and soil have doubtless been oxidized by the chemical action of alkali salts in the underlying clay stratum. In such places vegetation has been slow to recover its growth and consists of little more than small withered cacti. Though alkali is visible on the surface only in restricted areas, it is probable that the greater part of the type is somewhat affected by its presence. This is evidenced by the scant growth of native prairie grass which covers much of the soil. In its present condition the type provides considerable pasturage and could doubtless be as well employed for this purpose as for the growth of cultivated crops.

^a The word coulée is here used as locally understood.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Morton clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17665, 17667.....	Soil.....	0.1	1.1	0.5	5.5	8.6	60.4	23.2
17666, 17668.....	Subsoil.....	.1	.3	.4	3.5	13.6	50.9	30.9

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17665, 5.86 per cent; No. 17666, 2 per cent; No. 17668, 6.76 per cent.

MORTON STONY LOAM.

The soil of Morton stony loam consists of 6 to 12 inches of brown fine sandy loam or yellowish-brown silt loam, containing from 10 to 50 per cent of smooth, rounded gravel. The stones are chiefly granitic in character and range from one-half inch to 3 inches or more in diameter. Large granite boulders are also occasionally found embedded in the soil, but their occurrence is not common. The subsoil is usually a yellowish-brown silt loam with a somewhat smaller percentage of gravel than is found in the soil.

The Morton stony loam is the most limited soil type in the McKenzie area, being found only in the northwestern part in bodies ranging from 3 or 4 acres to a quarter section in extent. Many areas, too small to be shown on the map, are seen along the banks of streams and on the higher elevations throughout the Morton silt loam.

The Morton stony loam occurs as low, narrow ridges and rounded knolls, which, together with the open structure, give excellent drainage at all times.

The origin of the Morton stony loam is both glacial and residual. The gravel was carried by the ice from the regions to the north and deposited in its present position during Glacial time. Subsequently the stones became mixed with the finer residual material, though they are rarely found below a depth of 3 feet.

The native grasses found are usually rather short, especially during the dry, summer months, but, owing to the rapidity with which the soil dries out in spring, these knolls and ridges are the first to offer pasturage after the snows have disappeared.

Were it not for the difficulties of cultivation on account of the rolling topography, the soil would be adapted to the growing of potatoes, corn, vegetables, and other crops where earliness and freedom from frost are essential. As it is, the type is used only for pasture.

ROUGH BROKEN LAND (BAD LANDS).

Rough broken land is a term used in the McKenzie area to indicate a surface condition rather than a distinct soil type. Throughout the

west the areas are known as "Bad Lands." As the name implies, the surface features are extremely rough and rugged, which condition has given rise to a great variety of soil materials. On the bare sides of eroding buttes the soil consists of light-colored silty clay with a slight admixture of very fine sharp sand. On the tops of hills and ridges, where the silt and sandy materials have not been washed away, the soils are identical with the Morton silt loam and Morton fine sandy loam. These areas, though numerous, are usually very small, rarely exceeding a few acres in extent. On the steep sides of deep, narrow ditches which run between the buttes the soils range from silty clays to clean, sharp sand.

Not all of the lands in the McKenzie area having a rugged topography, however, are mapped as Rough broken land. The soils on many such areas possess a remarkable uniformity, and wherever this condition obtains the materials are mapped, according to texture, as Scoria gravel, Morton silt loam, or as Morton fine sandy loam, regardless of topographic features. Hence, only three extensive bodies of Rough broken land appear in the map. Of these, the one occurring along Prairie Dog Creek, in the southeast part of the area, is the largest and most important. This body, consisting of buttes, ditches, and high vertical walls, is continuous with the Rough broken lands along the Little Missouri River. The other bodies of the type are found on the east side of Bennie Pierre Creek in the northwest part of the area and in the western part of T. 147 N., R. 104 W. Other minor bodies are found associated with Scoria gravel hills in all parts of the area.

The topography of all these bodies is extremely rough, steep-sided valleys being found from 50 to 300 feet in depth and from one-fourth to one-half mile in width, separated from each other merely by a long, narrow ridge. Travel in such a region is very difficult and in many places quite impossible.

The Rough broken land owes its present condition almost entirely to erosion. Because of the admixture of fine, sharp sand in the silt and clay this action is proceeding at a very rapid rate. Each year the ditches grow deeper and their heads push farther and farther back into the level areas, so that the buttes and valleys are not only growing in numbers, but the areas of Rough broken land are continually spreading.

A large part of these rough lands is more or less affected by alkali salts. In places these have collected and formed a white crust over the surface of the ground, and where this has occurred vegetation is very scant.

The areas of Rough broken land are especially valuable for their extensive deposits of lignite coal. These veins underlie large areas and run from 1 foot to 8 or 10 feet in thickness.

On account of the activity of erosion in the Rough broken land numerous small bodies are found on which vegetation is exceedingly scant. The narrow valleys, however, and the lower parts of the buttes are usually covered by a moderate growth of native prairie grass. Occasional springs are also found in the valleys, and though the water is usually salty it is rarely so strong as to be rejected by stock. The occurrence of these springs and the shelter from the winds which the ditches and buttes afford make these areas especially desirable as a winter range for stock. The land is worthless for cultivated crops and should be used exclusively as pasture.

SUMMARY.

The McKenzie area comprises ten townships in the southwest corner of McKenzie County on the State line between North Dakota and Montana. Parts of the area are extremely rough and broken and the drainage is well established.

No agriculture is practiced in the area, the leading industry being the raising of stock. This is due to several causes, of which are: (1) The absence of adequate facilities for transportation, the nearest shipping points being Wibaux, Mont., 33 miles to the south, and Williston, N. Dak., 35 miles to the north; (2) the marked adaptability of the region to this special industry, beef cattle and horses being grazed the year around without any provision being made for their subsistence; and (3) the general lack of faith on the part of the people in the certainty of crop production without irrigation in the semiarid belt.

The region is very sparsely settled, only twelve ranches occurring within the area surveyed. All of these people are ranchmen of considerable experience.

Aside from the areas of Rough broken land, eight soil types were mapped. Of these, the Morton silt loam has the greatest development. For agricultural purposes this is the best upland soil in the area. During favorable years it should produce fair yields of small grains, hay, and potatoes.

The Morton fine sand and Morton fine sandy loam are the earliest soils, and enjoy the most freedom from frosts during the growing season. During the summer they are somewhat affected by drought, but with thorough cultivation should be adapted to potatoes and early truck.

In general the Wade silt loam of the valleys is the best land in the area. On this type irrigation could be practiced at small expense by constructing embankments across the valleys to withhold the annual floods of snow water in the spring, for use during the growing season. When this is done, the type will be well adapted to al-

falfa, small grains, potatoes, and a wide variety of crops. In its present condition the soil produces from one-half ton to $1\frac{1}{2}$ tons of prairie hay per acre, though it is chiefly used for pasturage.

The Rough broken land, as its name implies, is extremely broken in topography. The areas consist chiefly of buttes, ditches, and high vertical walls, making cultivation impossible. The occurrence of springs and the shelter from winds which the ditches and buttes afford make the type especially desirable as a winter range for stock. Throughout the type occur vast deposits of lignite coal, which are especially valuable in this treeless region.

The McKenzie area is located on the line between the farming country of the east and the ranching country of the west. Either of these industries could well be supplemented by the other, but if either is to be practiced to the exclusion of the other the live-stock industry should unquestionably predominate.

SOIL SURVEY OF THE BELLEFOURCHE AREA, SOUTH DAKOTA.

By A. T. STRAHORN and C. W. MANN.

DESCRIPTION OF THE AREA.

The Bellefourche area is located in the western part of South Dakota, within a few miles of the Wyoming State line. Nearly all of the area lies within Butte County, and the remainder, a few square

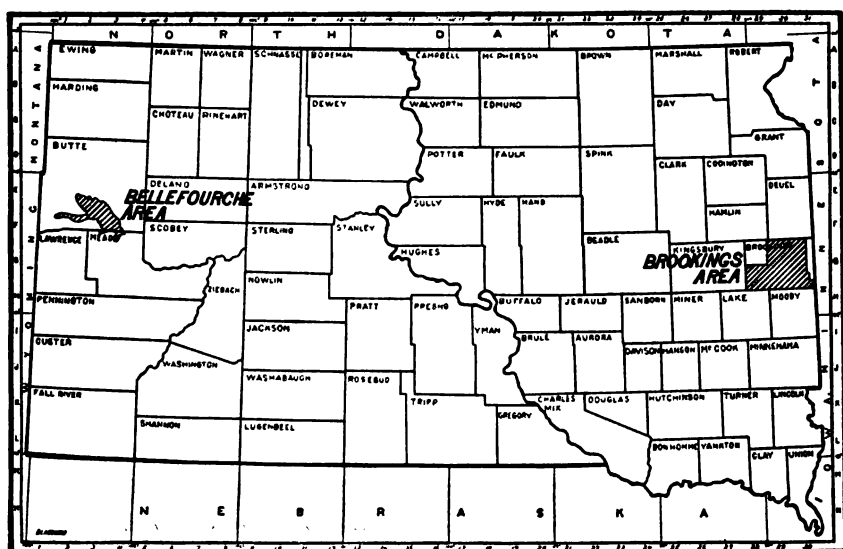


FIG. 30.—Sketch map showing location of the Bellefourche area, South Dakota.

miles of the southeastern part, falls within the boundaries of Meade County. The area comprises Tps. 7 to 10 N. and Rs. 2 to 7 E., Black Hills base and meridian, and includes about 121,000 acres of irrigable land. The shape of the area is very irregular, the boundaries being governed by the course of the Red Water irrigation canal, and by the course of the canals of the Government irrigation project. The greatest length of the area from east to west is about 30 miles, and the greatest width from north to south about 14 miles.

The area consists of the winding valley of the Bellefourche River, the narrow valleys of tributary streams, the high river terraces, and the rolling foothills forming the local watersheds. The largest stream

is the Bellefourche River, which, entering the area at the southwest corner, flows in an easterly direction with a very winding course and leaves the area at the extreme southeast corner. Its principal tributaries on the south side, from west to east, are Hay Creek, Redwater River, and Stinkingwater, Whitewood, Cottonwood, and Ninemile creeks. On the north side of the river, in the same order, are Crow, Owl, Horse, Dry, and Willow creeks. Of these streams, Redwater River and Whitewood Creek carry water during the entire year, as their sources lie well back in the hilly or mountainous regions south and southwest of the area. The other streams, draining a much smaller country, become dry soon after the cessation of the early summer rains. The drainage basin of the streams in this area is almost destitute of timber, and as a result the run-off of storm waters is rapid, and the streams, which rise rapidly following the heavy rains in the spring and early summer, soon fall to their normal level.

In general the formation of the land is such as to give a ready and thorough surface drainage. The exceptions to this are a considerable body of very level land in the western part of the area known as Indian and Owl creek flats, and a depression south of the proposed Government town site. Following the heavy spring rains the former region is almost impassable, owing to standing water and the sticky nature of the soil. The depression south of the proposed town site collects the surface storm waters from the adjacent country, forming a pond of some 200 to 300 acres in extent. Water usually stands in this depression throughout the summer.

This part of the country prior to the coming of the whites was inhabited by roving bands of several tribes of Indians, the Sioux tribe being the most numerous. Just when this section of the State was first traversed by white men is uncertain, but probably early in the eighteenth century. Before 1700 the Hudson Bay Company had an outpost on the Missouri River near the present site of Mandan, and a few years later the American Trading Company had an outpost near the present site of Pierre, on the Missouri. It is not unlikely that some of the trappers in their quest for furs ascended some of the streams in this part of the State. The fur business declined and for many years little was known of the Black Hills and surrounding country. Shortly after the civil war hunters and prospectors began to drift into the country and were soon followed by cattlemen, who found conditions ideal for the feeding of vast herds of range cattle. The coming of the whites was strenuously opposed by the Indians, particularly the Sioux, who caused considerable trouble until subdued soon after the Custer massacre and placed upon a reservation in the southern part of the State. Stories of gold in the Black Hills caused

a rapid increase in the population of that district, from which point settlers soon moved into outlying districts. Since then there has been a steady increase in the population of this section of the State.

There are four towns in the area, Bellefourche, Snoma, and Vale, all situated along the Bellefourche River, and Minnesela on Red-water River. The last of these was at one time the county seat of Butte County, but soon after the building of the railroad the courthouse was removed to Bellefourche. Snoma and Vale are small settlements in the more thickly settled part of the valley east of Bellefourche. Bellefourche is the principal town, and being situated on the Chicago and Northwestern Railroad, is the point of supplies for a vast stretch of country to the north and northwest. Prior to the construction of the railroad, in 1888, the obtaining of supplies was a costly and tedious operation for the settlers. All supplies had to be hauled into the area by wagons from distant points, Cheyenne, Wyo., Sidney, Nebr., Pierre, S. Dak., and Bismarck, N. Dak., all being prominent outfitting and supply points for this section of the State.

Railroad transportation is now afforded by a line of the Chicago and Northwestern Railroad, which gives a ready outlet to the Black Hills, Omaha, Lincoln, and Sioux City. A short line, known as the Wyoming and Missouri River Railroad, runs from Bellefourche to Aladdin, Wyo., which is a stock-shipping and coal-mining point. The eastern and southern portions of the area connect with the railroad by wagon roads to Whitewood and Sturgis, points on the Chicago and Northwestern line. At the present time practically all of the farm products are consumed within the area, or shipped into the Black Hills, while the sheep and cattle shipped out of the area go to some of the large packing-house concerns in Omaha, Chicago, and Sioux City. There is a good demand for all kinds of farm produce in the mining towns and surrounding country to the southwest.

CLIMATE.

The records of the precipitation and temperature for this area are very incomplete, the only record being that taken by the Reclamation Service, partly covering the last three years.

The normal annual rainfall for the area is estimated at about 17 inches, although it varies widely from year to year, ranging from about 12 to 20 inches. The larger part of the rainfall usually occurs in the spring and early summer, from March to the last of June. During this season very heavy rains are not unusual, as much as 3½ inches falling within twenty-four hours. The fall of snow is rarely heavy and seldom covers the ground for any length of time. Electrical storms are rare.

The mean temperatures at reservoir site, as recorded by the United States Reclamation Service, are as follows:

Mean monthly temperature at reservoir site.

Month.	1906.	1907.	Month.	1906.	1907.
January.....		12.0	July.....	71.4	68.2
February.....		27.9	August.....	68.5	
March.....		31.0	September.....	62.7	
April.....		39.6	October.....	48.0	
May.....	49.6	47.8	November.....	33.5	
June.....	62.0	62.5	December.....	27.0	

Some data regarding the precipitation at a few towns south of the Bellefourche area, in the edge of the Black Hills, are available. The figures given are the mean of average annual precipitation, based on records covering a period of over twenty years. They give an idea of the rainfall near the sources of many of the streams entering the area. The mean annual rainfall is as follows: At Spearfish, 21.8 inches; Rapid City, 16.34 inches; Fort Meade, 19.41 inches; Silver City, 22.05 inches. The total yearly rainfall at Spearfish varies between 12 and 29.4 inches.

The annual range of temperature in this area is wide, being about 130°. Winter temperatures of —30° F. have been recorded, while in July and August temperatures above 100° F. are not uncommon. The cold of winter is frequently modified by a warm wind from the southwest, locally known as the "chinook." On account of the low humidity neither of the extremes of temperature causes any serious results.

The average date of the last killing frost in the spring is about May 5, and of the first in fall is about September 15. As a rule very little damage is done to the crops by frost either in this area or nearer the hills.

Wind is a prominent feature of the climate of this area, as there is hardly a day without a good breeze, and in the spring and autumn months winds of high velocity may blow for several days at a time. The number of cloudy days is small.

In the following table are given the maximum and minimum temperatures, the mean monthly and annual temperature and precipitation, and the total precipitation, by months, for the wettest and driest years, and the depth of snow, as taken from the records of the United States Weather Bureau station at Spearfish, which lies a short distance south of the area surveyed.

Temperature and precipitation for Spearfish, S. Dak.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
January.....	25	65	-30	1.0	0.3	0.5	9.2
February.....	21	67	-30	1.0	0.4	0.8	10.6
March.....	30	80	-20	2.2	1.1	4.0	20.9
April.....	46	88	1	3.0	1.1	5.0	14.6
May.....	55	93	24	3.0	3.6	3.1	1.2
June.....	64	105	33	4.1	1.4	2.3	0.0
July.....	71	105	43	2.0	1.9	3.0	0.0
August.....	70	104	40	1.6	0.1	3.7	0.0
September.....	60	97	26	1.1	0.6	3.9	0.8
October.....	49	90	17	1.3	0.8	0.4	2.3
November.....	35	79	-11	0.6	0.2	0.6	5.8
December.....	31	71	-17	0.9	0.4	1.5	8.9
Year.....	46	105	-30	21.8	11.9	29.4	74.3

AGRICULTURE.

The earlier settlers in this area cared little or nothing for farming, their interests being centered in the cattle industry, the almost limitless range, with a plentiful supply of grass and water, making the area unusually well adapted to this pursuit. Owing to the requirements of the range, the dwellings were usually miles apart, and the farming areas were confined to small fields close to the ranch houses. Very few ranches could boast of a garden, it being considered easier to buy vegetables than to take the trouble to grow them. Native hay and oats or wheat, and occasionally corn for feeding the farm stock, were about the only crops grown.

When viewed in the light of good farming practice, the methods pursued by the earlier settlers in the production of these crops left much to be desired, and it is to be regretted that these methods are still in use by many of the farmers. The usual practice was to break the sod to a depth of 2 or 3 inches the first year in order to kill the grass and weeds, and to plant corn on the fresh sod with a hand planter. In the second year the method pursued in the cultivation of the land varied with different farmers. Many sowed wheat or oats directly upon the corn stubble without stirring the soil, save as this was done by the seeder. Others plowed the land the second year and planted the grain either with or without harrowing. In years of high rainfall good yields would be obtained, even with this inadequate preparation of the soil, but in seasons of deficient rainfall the yields were hardly sufficient to pay for the seed. While the above may be

taken as a fair average of the cultural practices of the earlier settlers, and even of the farm practices to the present time in the dry-farm districts, yet in many instances even less care was taken in the preparation of the soil, and cases are known where small grain following corn has been planted three or four years in succession without any plowing or cultivation of the soil. Such methods are becoming less common, and among the more recent settlers better cultural methods are noticeable and a somewhat wider variety of crops is produced. Alfalfa has been introduced, and the yields vary from $1\frac{1}{2}$ to $2\frac{1}{2}$ tons per acre, depending upon the rainfall. In addition to oats and wheat, rye, barley, and millet have been grown to a limited extent, fair yields being obtained without irrigation. Potatoes in favorable years give abundant yields. Brome grass is one of the most recently introduced crops, and although the acreage at the present time is very small, it gives promise of becoming a valuable addition to the crops grown without irrigation. In the last few years vegetable gardens near the ranch houses have become more common, and these in some cases, besides supplying the home needs, are proving profitable to the owners from the sale of the surplus in the local markets.

Up to the present time little or no attention has been paid to the selection of soils for particular crops. It is commonly held that the Pierre clay, or "gumbo," as it is locally known, produces better crops of hay and alfalfa than the lighter sandy soils. Little or no attention has been paid to the rotation of crops in this area, the question as to what to sow being decided by the immediate need and desire of the farmer.

The methods of dry farming might be greatly improved and the increased yields would in average years be more than sufficient to justify the extra time and money invested in the thorough cultivation of the soil. When the moisture in the soil is sufficient, the land should be deeply plowed in the fall, since this will materially aid in storing the moisture of the winter rains for the use of the summer crops. In the spring the ground should be plowed as early as the weather conditions will permit and then thoroughly harrowed. By these means a large part of the moisture in the soil will be retained for the growing crops. In growing cultivated crops, such as corn, the surface soil, subsequent to the seeding, should be thoroughly cultivated, so as to produce a mulch of loose soil to aid in holding the moisture. Not only should this loose condition of the surface soil be obtained in the spring, but cultivation should be continued throughout the growing season, particularly after the summer rains. In the planting of alfalfa and small grains, the sowing of a smaller amount of seed per acre will in general be found to give increased yields, since the moisture in the soil of dry-farmed districts is rarely sufficient for a thick stand of these crops.

In the irrigated district of this area, under the Redwater Canal, more attention is given to the preparation of the soil, although in some cases deeper plowing might be practiced with good results. While the soil is, as a rule, better prepared than in the dry-farm districts, in many cases the subsequent cultivation is neglected. It is not uncommon to see fields in which the corn is almost smothered by weeds.

In seasons of average rainfall very little trouble is had in curing hay, and this fact has made some of the farmers in the valley, particularly in the dry-farm section, careless in handling this crop. Fields were noticed where the hay had been allowed to remain on the ground in windrows from ten days to two weeks. This greatly reduces the value of the hay for feeding purposes, even though no rain occurs, and in rainy seasons it is badly damaged if not altogether ruined by this practice. The small grain is shocked in the field without capping, after which it is either thrashed directly from the shock or hauled and put into stacks until it is convenient for the owner to thrash.

This area, like most other farming sections of the West, suffers at all times from a lack of farm labor, and in the haying and thrashing seasons the need of help becomes pressing. Farm hands receive from \$25 to \$30 a month and board, when employed throughout the year. In haying and harvesting seasons help commands from \$40 to \$60 a month and board. Less than 20 per cent of the farms in this area are worked by tenants, the owners farming the larger part of the land.

The value of lands within the area varies widely and the general trend of values is upward. Up to within the last three or four years land outside of the irrigated district could be bought for \$7 to \$10 an acre, but since this area has been made into an irrigation project by the Reclamation Service the prices asked for these same lands have risen, and now range from \$12 to \$20 an acre. Very little of the land under the Red Water Irrigation Canal is on the market.

South of this area there is a well-cultivated and irrigated district along Spearfish Creek, a branch of Redwater River, and from the conditions which exist there some idea may be gained of what may be expected when this area is placed under irrigation. The soil in general along that stream is somewhat lighter than the average soil in this area, and is very much like the Vale loam, excepting that it is of a decidedly red color and contains some gravel. The conditions of rainfall and temperature are also very similar, though this valley is not so subject to heavy winds as the Bellefourche country. Alfalfa and the small grains yield abundantly, and corn in most years gives good returns. The growing of apples and small fruits has developed into a paying industry and there is a demand for more of these prod-

ucts than has been produced up to the present time. The growing of peaches is not considered profitable, since the trees can not withstand the winter climate. Plums do well, and pears, although just being tried, are apparently adapted to the region. Small fruits yield abundantly, but in unusually severe winters are damaged by the cold, and it has become the practice of the careful farmers to lay the vines down during the winter and cover them with earth. The Wealthy apple has proved to be well adapted to the valley and is gradually forcing out other varieties.

Some fruit is grown in the area surveyed, but in very small, widely scattered orchards, and not enough has been done in this line to show the capabilities of the soil for these crops. All of the orchards observed in this area have been on the lighter textured soils, and the trees seem to be making good growths and giving fair yields. The larger proportion of this area has a very heavy soil, and its adaptability to the fruit industry is as yet an unsolved problem. If the fruit industry is to be developed and made profitable in this area, it is probable that the trees and vines will need to be protected from the heavy winds which blow during the spring months, by windbrakes of trees planted around the orchard, just as is done in some parts of California.

SOILS.

The rocks from which the soils of this area have been derived are largely the Pierre shale, and, to a lesser extent, several geological formations in and adjacent to the Black Hills. The basal formation of this area is the Dakota Sandstone of the Cretaceous age, and this is the lowest formation within the area which is of any importance. This sandstone was deposited early in the Cretaceous age, following which there was a period of clay deposition, the material accumulating to a depth of several hundred feet and subsequently indurating to form the Pierre shale. Three soils are made up entirely of material resulting from the decomposition of this shale. These soils—the Pierre clay, Orman clay, and Pierre clay loam—differ from one another in texture, topography, and mode of formation, being, respectively, residual, lacustrine, and alluvial in origin. The other soils in the area are not derived from the Pierre shale, but are underlain at varying depths by the shale or by-products resulting from its decomposition. The upper portion of these soils is made up almost entirely of material eroded from a variety of rocks in the Black Hills and transported and laid down by streams issuing from that region. The products of the decomposition of the shale have had a minor influence in a few cases on these lighter soils, where the two classes of material have been intermingled. With the exception of the Vale gravelly

sandy loam, which is colluvial in formation, the lighter soils are all alluvial.

The residual soil occurs over nearly all of the eastern part of the survey, north of the Bellefourche River and east of Horse Creek, and in scattered areas throughout the balance of the area surveyed. The lacustrine soil occurs along the western edge of the area and the alluvial throughout the rest of the area.

The following table gives the name and extent of each of the soil types in the area:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Pierre clay.....	41,068	33.9	Vale loam.....	3,520	2.9
Pierre clay loam.....	24,192	19.9	Vale gravelly sandy loam.....	2,304	1.9
Vale fine sandy loam.....	23,986	19.7			
Orman clay.....	14,912	12.3	Total.....	121,344	-----
Meadow.....	11,392	9.4			

MEADOW.

The texture of the Meadow type of soil varies from a clay to a gravelly loam, the texture being due to the soils from which the streams erode the soil material. Where this type occurs along streams flowing into the Bellefourche River from the north the texture of the soil to a depth of 6 feet is a heavy impervious clay. Those areas occurring along the Bellefourche River and along the water courses flowing into it from the south are generally sandy loams, varying from coarse to fine, underlain by a bed of waterworn gravel and sand. In a few places this gravel forms nearly the entire type, only a thin layer of soil being on the surface to serve as a foothold for vegetation.

The color of the heavier phase of this type is a dark brown or black at the surface, due to organic matter in the soil, while the subsoil is a light brown, or, rarely, a yellowish brown. In the lighter phase of the soil the color is a light brown or, where very sandy and gravelly, yellowish.

Meadow occurs as small irregular bodies along nearly all the water courses in the area. Along the Bellefourche River the surface of the soil is fairly uniform, occasional small depressions marking the courses of a part of a former stream. Along the smaller streams the surface is so uniform that it is hard to note any exceptions.

The drainage of the lighter portions of this type is excellent, owing to the open texture of the soil and the gravel in the subsoil. In the heavier portions of the type the drainage is poor, owing to the impervious subsoil, and swampy conditions exist throughout the year in the lower-lying areas.

The Meadow owes its origin to the periodical overflows of the streams in the spring and the deposition of soil material carried in suspension by them. The streams through the northern part of the area receive their waters from a region made up of a clay soil, and the material eroded and carried by them is very fine, and when deposited forms a heavy clay soil, which is the heavier phase of this type. The streams through the southern portion carry coarser material in suspension, and this forms the sandier phase of this soil. A few small areas of this type have been formed since irrigation has been practiced on the lands south of the Bellefourche River, and these are due to seepage of irrigation waters from higher levels to lower lands of deficient drainage.

With few exceptions, the bodies of this type lying along the streams in the northern and western parts of the area contain alkali, a large proportion of the Meadow area having an average alkali content of from 0.40 to 0.60 per cent for the upper 6 feet of soil. A smaller proportion contains alkali averaging from 0.20 to 0.40 per cent, while a little of the type—the lighter phase—is entirely free of alkali. Owing to the periodical overflows and the consequent saturation of the upper portion of the soil there is seldom any injurious amount of alkali in the first 24 inches. Below this the quantity of alkali usually increases with the depth.

Along the Bellefourche River the Meadow supports a luxuriant growth of cottonwood, willow, ash, and elm, and a good growth of grasses and weeds. Along the smaller streams the timber is less abundant, but there is found a heavy growth of native grasses, which make good hay and excellent pasturage.

Up to the present time only a few small, widely scattered areas of the Meadow are cultivated, and the yields obtained depend largely on the extent of the spring floods and the amount of the early summer rains. With the increase in population and the demand for farming land this type of soil should become of importance, the lighter phase being well adapted to the growing of vegetables, while with proper handling the heavier phase should be a strong, lasting soil.

VALE GRAVELLY SANDY LOAM.

The Vale gravelly sandy loam consists of a light-brown coarse sandy loam, or a fine sandy loam carrying varying quantities of water-worn gravel, the proportion usually increasing with the depth. The gravel ranges in size from fine gravel to pieces 4 to 5 inches in diameter. In exposures along river terraces or in excavations it is found that the sandy surface material forming the soil is usually underlain at 3 to 10 feet by finer and heavier material, generally a clay loam.

This soil occurs principally along old river terraces, marking the course of former streams, along the higher banks of the present course

of the Bellefourche River, and as small, low elevations throughout the southern part of the area. The surface is generally uneven and along the river terraces frequently precipitous.

The Vale gravelly sandy loam is formed by the material brought down by the streams from the northern part of the Black Hills and adjacent country.

In the past this type of soil has been of little or no agricultural importance, it being used only as pasture in connection with adjoining lands. A larger part of its area will never be of value for agriculture on account of the steep surface, and the remainder is not suitable for dry farming, as the soil dries out rapidly in the summer. Under irrigation the more level areas should prove well adapted to such fruits as thrive on gravelly soils and as can withstand the winter climate of this region.

The following table gives the results of the mechanical analysis of a fine-earth sample of the soil:

Mechanical analysis of Vale gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
17764.....	Soil.....	3.0	10.9	9.6	27.8	13.8	24.4	9.5

VALE FINE SANDY LOAM.

The Vale fine sandy loam may consist of 6 feet of fine sandy loam, but is frequently underlain at 24 inches by a clay loam extending to a depth of 6 feet or more. The subsoil frequently contains thin layers of a lighter material, usually a sandy loam. The texture of the surface soil varies considerably with the topography, some of the higher areas approaching a sand, owing to the removal of the finer material by surface washing, while lower-lying areas approximate a heavy fine sandy loam or a silt loam. The clay loam subsoil is very compact, and below 6 feet it usually grades into a clay which extends to 12 or 16 feet, where it is underlain either by a heavy clay, locally known as "blue clay," or by a bed of waterworn gravel. The usual color of the soil is a reddish brown, which weathers to a light brown on the surface. The subsoil varies in color from a dark to a light reddish brown.

The Vale fine sandy loam is found in the southern part of the area, the largest bodies occurring on the south side of the Bellefourche River northeast of Bellefourche and east of Vale. A narrow area, becoming wider at its eastern end, extends along the north side of the river from the diversion works of the Government irrigation system to the mouth of Owl Creek. Small, scattered, irregular areas

occupy the lower lands on the north side of the river from the mouth of Owl Creek to the eastern limit of the survey, and a few irregular areas occur west of Vale between the hills and the Bellefourche River and extend along the line of the canal. In the western part of the survey there are no very prominent topographic features connected with this type, the rather uniform slope to the river being broken only by a few shallow draws and by a somewhat ill-defined old river terrace.

Eastward to Vale the larger portion of this type lies along the lower levels and but little above the overflow land along the river. Southwest of Miller Butte an area of this soil occurring on a high bench has a very level surface, excepting a depression near the western edge, which usually contains water throughout the year. East of Vale this soil occurs in two or three benches, with more or less well-defined escarpments between them.

The Vale fine sandy loam is an alluvial soil and owes its origin to material carried by streams draining the Black Hills country and deposited above the heavier subsoil, which is partly made up of material derived from Pierre shale.

This soil is practically free from alkali. Northwest of Bellefourche, below the Redwater Canal, there is a small area where traces of alkali occur, though not of sufficient extent to map. East of Vale, near the Bellefourche River, there is an area where widely-scattered spots contain traces of alkali. In a few localities where the subsoil is heaviest small amounts of alkali occur in the fifth and sixth foot, but not in sufficient quantities to be indicated on the map.

Dry farming and farming under irrigation are both practiced on the Vale fine sandy loam. In the dry-farming sections this soil produces good crops in years of average rainfall, alfalfa yielding on the average about 2 tons per acre, oats 25 bushels, and corn 15 bushels. In years of deficient rainfall dry-farm crops on this soil will hardly return the seed planted in the spring. All of this type south of the Bellefourche River and to a point about 2 miles east of Snoma is under irrigation, water being obtained from the Redwater Canal. Under irrigation this soil has proved well adapted to the crops grown in this section, alfalfa and oats giving heavy yields. Alfalfa produces from 5 to 7 tons per acre with three cuttings, oats 60 to 70 bushels, and wheat 25 to 35 bushels. Corn gives good returns, but in seasons of early frost it sometimes fails to mature. The soil is loose and easily handled, and with irrigation should prove adapted to a wider range of crops. A few small orchards are found upon this type, and the trees seem to be making a good growth. With proper protection from winds it is likely that apples, cherries, and a variety of small fruits would succeed on this soil.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Vale fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
17755-----	Soil.....	0.1	0.7	0.3	8.4	24.5	55.9	10.7
17756-----	Subsoil.....	.1	.5	.8	14.9	33.5	37.3	12.0

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17755, 3.90 per cent; No. 17756, 4 per cent.

VALE LOAM.

The Vale loam is variable in texture and occurs in this area in two phases—a loam phase and a sandy loam phase—the latter not occupying a sufficient area to be indicated upon the soil map.

The heavier phase, to a depth of from 12 to 30 inches, consists of a loam. This is underlain by a clay loam, rarely a clay, to a depth of 6 feet. In a few small areas the surface 2 inches is made up of fine sandy loam. Below 6 feet the soil is heavier, and at 12 to 16 feet it rests either on a heavy clay or on a bed of waterworn gravel. The soil contains varying quantities of gravel, particularly in the vicinity of old stream terraces. The color of the soil is brownish, with usually a reddish tinge, while the subsoil is darker and frequently contains yellowish-brown streaks.

The light or sandy loam phase consists of 6 feet of heavy, sticky, sandy loam, containing quantities of fine gravel. Like the heavier phase, it rests either on clay or gravel at 12 to 16 feet. The color of this phase is a light reddish brown.

The Vale loam occurs in the southern part of the area surveyed as irregular-shaped widely separated bodies, the largest of which lies mainly between Whitewood and Cottonwood creeks, west of Vale. A part of the type occurs between Bellefourche and Snoma below the Redwater Canal, and two small areas near the southeast corner of the survey.

The surface in the western part of the survey slopes toward the Bellefourche River, and the drainage is excellent. Near the line of the Redwater Canal the slope is quite pronounced, but becomes more gradual toward the river and adjoining soils. Shallow washes or gullies traverse the areas at intervals, making the surface somewhat rolling. In the area west of Vale the surface is for the most part level, and adjacent to the river it is cut by a narrow strip of Vale gravelly sandy loam, which marks the course of a prominent river terrace. It is in this area that the heavy subsoil comes near the surface, and on

account of the rather level surface and compact subsoil the drainage is deficient. A small arm of this area extending toward Butte Hill has a good slope, and here the drainage is better.

The Vale loam is both a lacustrine and alluvial soil, parts of the type having been laid down in bodies of water once covering this area, and other parts having been formed by the deposition of material carried in suspension by former streams. The latter areas have been somewhat modified since their deposition by the addition of small quantities of material washed down from the higher slopes of the foothills, making the surface soil somewhat more heavy than the outlying portions. At present this type does not contain sufficient quantities of alkali to be indicated upon the map, though in some areas small quantities of alkali are found in the fifth and sixth foot, which may be brought to the surface if faulty methods of irrigation and cultivation are practiced.

The western areas of this soil are under irrigation, the water being obtained from the Redwater Canal. Alfalfa and small grains, principally oats and wheat, do well, and the yields approximate those obtained on the Vale fine sandy loam. The other areas of the type are not irrigated, and very little of it is cultivated.

The larger part of the soils in the Redwater and Spearfish valleys is made up of a loam similar to this type, differing, however, in color and in being underlain at from 5 to 10 feet by beds of gravel. In these valleys soil of this character has proved well adapted to apples, plums, cherries, and small fruits.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Vale loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
17768.....	Soil.....	0.4	3.3	4.2	15.6	20.1	31.9	23.9
17759.....	Subsoil.....	.2	4.3	4.8	38.8	7.9	28.2	15.1

PIERRE CLAY LOAM.

The Pierre clay loam consists typically of from 12 to 30 inches of rather heavy clay loam, underlain to 6 feet by a very heavy tenacious clay. In a few cases the clay loam extends to a depth of 6 feet. The soil is light brown in color, which weathers upon the surface to a whitish or ashy-gray. The subsoil is almost invariably of a brown color, although yellow streaks are sometimes found below 3 feet. In the subsoil of the higher lying areas there often occur small, roughly cubical fragments of a grayish or light-brown stone, derived from the weathering of the clay concretions occurring in the Pierre shale. Below 6 feet the soil continues a heavy clay to a depth of 10 to 40 feet

or more, where it is underlain by a heavy blue clay. Occasionally a thin bed of gravel overlies the clay. Bodies of this soil lying south of the Bellefourche River have at times come under the influence of streams draining the Black Hills, and sometimes contain small quantities of waterworn gravel.

Next to the Pierre clay, this type of soil is the most extensive in the area, and occurs as isolated bodies or as bodies covering a considerable section of country. The most extensive development is found along Horse Creek. A fair-sized area occurs in the vicinity of Vale, and small areas are found along Ninemile Creek and in the southwestern part of the survey.

The Pierre clay loam, on account of its wide distribution, has a variety of topographic features, ranging from low, poorly drained areas to the slopes of the foothills. Southwest of Vale a part of the soil has rather poor drainage, owing principally to the construction of a small irrigation reservoir on Cottonwood Creek. The land near the reservoir has a gentle slope and during the spring rains it becomes wet from overflow waters. The larger part of the type, however, has excellent surface drainage. There is practically no movement of water downward, as the subsoil in unirrigated areas was very dry, notwithstanding the unusually heavy rainfall during the spring of this year (1907). In the areas under the canal the continued application of irrigation water for a series of years has had but little effect on the subsoil, which is only moderately moist.

The upper part of the soil, and in some cases the entire soil, is of alluvial origin, while a larger part of the subsoil is residual, resulting from the decomposition of Pierre shale.

South of the Bellefourche River the Pierre clay loam contains but little alkali, the areas being small, with an average alkali content of 0.20 to 0.40 per cent for 6 feet of soil. In the southeastern part of the survey, along Ninemile Creek, traces of alkali occur near the stream and tributary draws, but in areas too small to be shown on the map. North of the Bellefourche River the larger part of the soil contains alkali in sufficient quantities to be mapped. The upper 18 or 24 inches of soil is generally free from harmful quantities. In irrigating this soil care should be taken to prevent the rise of the alkali to the surface and the injury of the land. Although even where alkali accumulates it will be feasible to reclaim the land, the process is slow and costly in soils of this heavy texture, and the better way is to guard against the evil. Some of the lower lying areas will undoubtedly suffer from a rise of alkali soon after irrigation is commenced, but by proper attention much of the type can be farmed for many years with no serious results. On the areas along the canal no injurious effects have been noticed from the use of irrigation water, as the soil

in these portions possesses good surface drainage and the excess of water flows off to lower levels.

The Pierre clay loam supports a good growth of grass, and is used to a limited extent as a range for stock. The areas near the streams are used for wild hay. A considerable portion is farmed without irrigation, the principal crops being alfalfa and oats, with some wheat and corn. The yields obtained vary widely, being dependent upon the annual rainfall, but the following estimates are approximately correct: Alfalfa 2 tons, oats 30 bushels, wheat 15 to 20 bushels, and corn 12 bushels per acre. There seems to be no reason why, with more careful cultural methods, larger yields may not be secured.

On account of the heavy, sticky nature of this soil, it requires careful handling in order to obtain a good seed bed. If stirred when too wet the soil forms into hard clods, which are almost impossible to break down by cultivation, while if plowed when too dry the soil breaks into a fine dust, which will blow badly and render irrigation of the fields difficult.

The following table gives the average results of the mechanical analyses of the soil and the results of a single determination of the subsoil constituents of this type:

Mechanical analyses of Pierre clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17747, 17749.....	Soil.....	0.1	0.5	1.9	11.1	21.5	44.4	20.2
17748.....	Subsoil.....	.1	.1	.4	1.5	16.0	48.1	33.6

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17747, 3.45 per cent; No. 17748, 5.95 per cent.

PIERRE CLAY.

The Pierre clay consists of 6 feet of an extremely heavy tenacious clay, which, particularly in the eastern portion of the area, contains considerable quantities of small light-brown or gray cubical fragments of broken-down clay concretions. Throughout the area frequent small knobs or elevations only a few inches high mark the location of these weathered concretions, which have not been scattered through the soil. Sometimes the soil does not extend to a depth of 6 feet, but such occurrences are rare. Where this occurs the soil is harder and more compact and passes gradually into beds of weathered shale. The surface of the Pierre clay has a whitish or ashy-gray color, while below the surface the color varies from light to dark brown. If the lower soil is exposed it slowly loses the brown color and becomes a light gray.

The Pierre clay is the most extensive of the soils of the Bellefourche survey, occupying about one-third of the total area. It covers nearly all the area north of the Bellefourche River and east of Horse Creek. Other smaller bodies of the type lie along Owl Creek, north of Indian Creek, and near Snoma. None of this type has been found on the lands under the irrigation project south of the river.

The surface is generally irregular, on account of numerous water courses and draws, with prominent hills and ridges between the streams. In the eastern part of the area the erosions are numerous and deep, making the surface very irregular. Excepting a few depressions which hold water seeping from surrounding land, the drainage is excellent.

The Pierre clay is a fine example of a residual soil, having been formed by the slow weathering of the immense beds of Pierre shale underlying the entire area. Erosion subsequent to formation of this soil has cut down the original surface, resulting in the present topography, varied by hills, valleys, and stream courses.

The larger part of the area of this soil contains alkali in sufficient quantities to be indicated upon the map, and over much of the affected area the content is high enough to cause some concern as to the results when irrigation waters shall be applied. The heavier accumulations of alkali in this type occur north and south of the proposed Government town site, in both cases the alkali content ranging from 0.60 to 1 per cent for the upper 6 feet of soil. Aside from these areas of high concentration, the area of alkali soil of this type is about equally divided between the grades of 0.20 to 0.40 per cent, and 0.40 to 0.60 per cent.

A portion of this soil, on account of the good surface slope, may never be troubled with dangerous accumulations of alkali, but over the larger part extreme care will be required in irrigation if serious damage from alkali is to be prevented. Owing to the extremely heavy nature of the soil, the movement of the alkali will be slower than in the lighter soils, but it will be none the less certain. The reclamation of the soil would be slow and expensive, and the conditions leading to the need of reclamation should be avoided.

The Pierre clay produces a fair growth of native grasses, and is largely used for grazing. On the lower lying areas the growth of native grasses is better, and small patches are cut for hay. The acreage which is farmed is relatively very small, and the greater part of the type is still unpatented land. Outside of the irrigated sections the farming is confined to small areas near the farmhouses. Very often the farming consists of a little patch of small grain on land that is being homesteaded, in order to secure the title to the land. Near Snoma, where this soil is irrigated, it gives promise of good crop

returns. The yields obtained from this irrigated section are similar to those obtained on the Pierre clay loam.

The following table gives the average results of mechanical analyses of the soil of this type:

Mechanical analyses of Pierre clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
17750, 17751.....	Soil.....	0.2	1.1	1.4	5.5	18.0	48.2	35.0

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17750, 2.32 per cent; No. 17751, 0.59 per cent.

ORMAN CLAY.

The Orman clay consists of 6 feet of extremely heavy, tenacious clay. In one or two cases, near the streams, the clay was found to be underlain at 4 feet by a heavy sandy loam or by a sandy loam with gravel extending to a depth of 9 feet or more. Rarely this type contains fragments of shale concretions like those found in the Pierre clay, although along the line of contact with the latter soil a few of these are occasionally found.

The Orman clay occurs in a large body in the northwestern part of the area, extending over what is known as Indian and Owl creek flats, and in two smaller areas in the eastern part of the survey near the Bellefourche River.

The topography of the Orman clay is in striking contrast to the topography of the rest of the area surveyed, since with the exception of a small gullied area west of the northern part of Indian Creek the surface is extremely flat. The two small areas of this type in the eastern part of the survey are also very level, the one adjacent to the Bellefourche River terminating in a high bluff at the water's edge. Across the western portion of this type Owl and Indian creeks have cut a flat-bottom draw, often a quarter of a mile wide, with the bottom of the stream from 10 to 20 feet below the surface of the plain.

On account of the very level surface the drainage is not good, and during the spring rains the surface is under water. Some of this water finds its way into one or the other of the two creeks, but a considerable portion remains on the surface until removed by evaporation.

The Orman clay is of lacustrine formation, the soil having been laid down in a large body of water which at one time covered this part of the area. The material of which the soil is composed is the finer products derived from the decomposition of Pierre shale.

Alkali is distributed generally throughout this soil and in such quantities that with irrigation there will be great danger of the larger portion of the land being rendered worthless for agriculture. At present there is very little alkali in the first 18 inches of soil, but below that depth the percentage is high. The entire area in the western part contains on an average from 0.40 to 0.60 per cent of alkali to a depth of 6 feet.

Owing to the very level surface and the lack of adequate drainage, in order to prevent the accumulation of alkali more care will have to be taken in irrigating and cultivating this soil than with any other in the area. The alkali content of the subsoil is high, and under conditions which exist it is hard to see how damage is to be entirely prevented. By care in the use of water and by thorough cultivation a considerable time will elapse before any injurious effects will be noted. The early construction of drainage ditches would do much to aid in keeping down the alkali.

At the present time hardly any land of this type of soil is under cultivation, but aside from the alkali problem it is probably well adapted to the crops grown in this section.

The following table gives the average results of the mechanical analyses of the soil of this type:

Mechanical analyses of Orman clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17752, 17753.....	Soil.....	0.0	0.0	0.2	4.2	11.0	47.7	36.1

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 17752, 1.36 per cent; No. 17753, 1.50 per cent.

IRRIGATION.

Up to the present time the only successful irrigation works in this area have been the Redwater Canal and a private canal taking water from a reservoir near Vale. From time to time since the settlement of the valley, attempts have been made by the settlers to take water from the Bellefourche River or some of its tributaries, but owing to the large volume of water sometimes carried by these streams, the irrigation works have been repeatedly destroyed, until the settlers have become disheartened and have ceased their efforts to irrigate the lands. Some living along the larger creeks have endeavored to construct earthen dams across the streams, so that in times of high water the streams would flow across adjacent hay lands and thus insure a larger yield of native hay. Owing principally to faulty

construction, these dams have soon given way under the pressure of the water, and these attempts have also been abandoned. Small reservoirs have been constructed in various parts of the area along the smaller streams, but these are largely used for watering stock rather than for irrigation.

The main sources of the water for irrigation are Bellefourche and Redwater rivers. The Bellefourche rises in Wyoming west and northwest of the Black Hills, and drains a rolling, treeless country with a heavy compact soil. As a result the discharge of this river is very irregular and given to sudden rises following the spring storms. In seasons of unusual rainfall, the river overflows large areas of adjoining land, doing more or less damage to bridges, farm buildings, and live stock. Below is given the discharge of this stream as determined by the United States Reclamation Service.

Estimated monthly discharge of Bellefourche River.

[Drainage area, 4,265 square miles.]

Month.	Total discharge.			Depth of run-off.		
	1903.	1904.	1905.	1903.	1904.	1905.
	<i>Acre-feet.</i>	<i>Acre-feet.</i>	<i>Acre-feet.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
March.....		^a 46,601	^b 17,030		0.20	0.075
April.....		30,967	17,140		.14	.076
May.....		32,684	46,850		.14	.206
June.....	10,955	158,432	35,880	0.05	.70	.157
July.....	12,343	20,770	64,200	.05	.00	.282
August.....	56,016	7,740	48,510	.25	.03	.213
September.....	54,363	14,717	15,170	.24	.06	.067
October.....	10,870	^c 10,241		.05	.04	

^a March 10-31.

^b March 5-31.

^c October 1-15.

The Redwater River, which rises southwest of Bellefourche, in Wyoming, drains the northern and northwestern parts of the Black Hills and adjacent country and empties into the Bellefourche River just east of the town of Bellefourche. This stream takes its name from the color of the water during times of high water, when it is a bright red, caused by material eroded from several geological formations having this color. The flow of this stream is not as great as that of the Bellefourche River, and although there is considerable variation in the discharge between high and low water stages, yet the rises are never so sudden as in the larger stream. The Redwater River receives its waters from a district which is partly forested, and the run-off is less rapid following heavy rains. The discharge of this river at its junction with the Bellefourche, for 1904, as determined by the United States Reclamation Service, is given on the following page.

Discharge of the Redwater River.

Month.	Discharge.	Depth of run-off.	Month.	Discharge.	Depth of run-off.
	<i>Acre-feet.</i>	<i>Inches.</i>		<i>Acre-feet.</i>	<i>Inches.</i>
January.....			July.....	10,890	0.201
February.....			August.....	5,688	.106
March 10-31.....	9,295	0.172	September.....	10,710	.198
April.....	13,210	.244	October.....	13,030	.241
May.....	8,854	.164	November.....	11,600	.214
June.....	65,220	1.20	December.....	13,400	.248

The combined flows of these two streams will furnish water for the irrigation system now in course of construction by the United States Reclamation Service.

Chemical analyses of water taken from the Bellefourche and Redwater rivers show respectively only 148 and 106 parts total solids per 100,000, from which it will be seen that it is well suited for use in irrigation, as the quantity of dissolved material carried is not sufficient to be harmful to crops.

In 1887 a merchant at Vale purchased water rights on Cottonwood and Whitewood creeks, and a right of way for a canal from these streams to a point near Vale. A dam was built across Whitewood Creek, a canal constructed, and water delivered to a few acres sown to alfalfa in 1890. The reservoir filled up with silt and sand in a few years, and was abandoned. Another dam was constructed on Cottonwood Creek and has been in use since 1895. The capacity of this reservoir is about 2,000,000 cubic feet. It irrigates a small field of alfalfa just south of Vale. In seasons of deficient rainfall little water is caught in the reservoir and little or no land is irrigated. The yield of hay varies from 2 to 5 tons per acre, depending upon the quantity of water stored.

The construction of the Redwater Canal was begun in 1878 and was gradually extended until in 1889 it reached Stinkingwater Creek, 5 miles east of Snoma. Water was delivered to the end of the line for only a short time, and the end of the canal has been at a creek about $1\frac{1}{2}$ miles east of Snoma for many years. The water for this canal is taken from the Redwater River at the junction of this stream and Flat Bottom Creek, about 2 miles south of the boundary of this survey. A portion of the canal southeast of Bellefourche passes along a steep gravelly hillside where there is some loss by seepage, but over the remainder of its course it traverses a rather heavy soil which holds the water well. The canal was originally constructed to carry about 100 second-feet, but it has not been kept in repair and the flow at the present time is considerably less. The lower end of the canal carries hardly sufficient water to supply the farmers in that locality

the quantity necessary for their crops. The Redwater Canal irrigates about 5,000 acres of land, and there are about 3,000 acres more which might be irrigated from this ditch.

The United States Reclamation Service is now engaged in the construction of an irrigation system which will, when completed, furnish water for the irrigation of about 95,000 acres, and will extend to all of the land within the area surveyed, excepting the higher elevations and the land now under the Redwater Canal. The construction of this system includes the building of a dam and weir to divert the waters of the river, a supply canal leading to the reservoir from the diversion works, an earthen dam at the reservoir site, and a system of canals and laterals for the distribution of the water.

The dam at the reservoir is one of the largest of its kind, and when completed will, at the high-water mark, retain about 246,016 acre-feet, with a water surface of 9,000 acres. Two main canals will carry the water to the laterals. The North Side Canal, forming the northern boundary of the area, will have a capacity of 582 second-feet at the head. The South Side Canal will have a capacity of about 240 second-feet at the dam. The first canal will supply water for about 66,875 acres and the South Side Canal will cover about 28,200 acres. About half of the land is Government or school land, and the rest is in private ownership.

It will be some time before all the lands under the Government project will be supplied with water, but by an order of the Secretary of the Interior, dated June 21, 1907, about 12,000 acres will be supplied with water in the spring of 1908. All of this land is in private ownership, and lies along the north side of the Bellefourche River from the diversion works eastward to the point where the South Side Canal crosses the river.

The Redwater Canal can, as it now stands, supply the land below it with water, but unless enlarged and cleaned out it will not be able to cover any more country. There is a body of land lying east of Snoma to Stinkingwater Creek admirably located for irrigation, which might be covered by this canal if the latter were put in better shape and extended.

The surveys made by engineers of the Reclamation Service show that there is a considerable body of land east of Willow Creek, beyond the present area, which may be irrigated by an extension of the canals of the present system when the demand for these lands shall arise.

Since alfalfa and small grain occupy the largest acreage, flooding the fields is the usual method of irrigation. A considerable quantity of water is lost by this method, as few of the fields are carefully graded, and water frequently runs from the lower edge of the field before the crop has been given the necessary moisture. By this method certain parts of the field receive an excess of water, while

others do not receive enough. On account of the surface slope of the land near the canal, flooding will probably continue to be the usual method of applying the water, but on the outlying fields basin irrigation might be practiced, with a more economical use of the water and the certainty that all of the crop will be evenly irrigated. In the case of open-culture crops, as corn and potatoes, the furrow method of irrigation is used.

The number of applications of water varies with the crop and with the individual farmer. Alfalfa is irrigated after each cutting, and also in the spring if the rainfall is slight; but many of the farmers apply water to the alfalfa between the regular irrigations which follow the cuttings. The larger number give the small grains three irrigations, but from the experience of a few in the valley it is evident that two thorough applications of water are sufficient to mature the grain and insure good yields in any but the driest years.

Under the Redwater Canal the water is sold to the farmers at \$1.50 for a miner's inch, which is commonly taken to be sufficient for an acre of land. Those living at the lower end of the canal are charged \$1.50 an acre, and use as much water as comes to them. In years of unusually low flow in the Redwater River these farmers sometimes do not receive the necessary water for their crops, while in years when the water is abundant they have more than they can use. Many who irrigate 100 acres or more find that they can make an inch irrigate more than 1 acre, and only take about 80 to 85 inches for 100 acres.

Under the Government system it is proposed to allow about 2 acre-feet of water for the land. The cost of this water will be a certain amount per acre. The cost of the irrigation system will be assessed against all irrigated lands within the project, and this is to be paid to the Government by the farmers in ten annual installments. In addition to this yearly cost per acre, there will be a small charge for the maintenance of the system. On that part of the project to be thrown open for irrigation in 1908 the annual charge for water has been fixed at \$3.40 an acre. Three dollars of this amount is to be a payment on the construction and the remainder for maintenance.

ALKALI.

With the exception of the Vale series of soils, alkali is generally present in the soils of the Bellefourche area north of the river. South of the river alkali is found only in small quantities and in restricted areas. The larger part of the higher slopes and ridges is practically free from alkali; a few cases were noted where there were small quantities of alkali below 3 or 4 feet, but not enough to map. The immediate bottoms along streams and the adjoining land, north of the Bellefourche River, with hardly an exception, contain rather

large quantities of salts. Over the greater part of these lands the proportion ranges from 0.40 to 0.60 per cent for a depth of 6 feet, and a few areas occur where the concentration is from 0.60 to 1 per cent. On the slopes above these lower lands in widely scattered areas the average amount of alkali in the soil is from 0.20 to 0.40 per cent. Aside from the area shown on the map to contain alkali, there are areas, particularly in the southeastern portion of the survey, where the content is rather high along swales, creek banks, and in very small spots. Owing to the small extent of these areas, it is not possible to show them on a map of the scale used in the survey. A few small areas of similar nature occur in the irrigated lands under the Redwater Canal.

The Pierre shale, which underlies the whole area, carries in seams and fissures considerable quantities of salt, particularly gypsum. Almost all the soils found in the area have been derived from this formation, either directly or indirectly, and have received the alkali from the same source. Under the Redwater Canal the small alkali areas have been formed by the movement and accumulation in poorly drained places of irrigation waters from the higher lands, the alkali resulting from the evaporation of the water.

The salts composing the alkali in this area are gypsum, which is almost always present, sodium sulphate, and magnesium sulphate. Chlorides of these bases are very rare, as are the bicarbonates. Qualitative tests of soils and waters in the field have shown that these last two are frequently wanting, and never occur except in small quantities. Carbonates, or black alkali, are absent and will probably not occur in the soils of this area on account of the amount of gypsum in the soil.

Below is given an analysis of an alkali crust, showing the alkali constituents, and the percentage of each salt present.

Chemical analyses of a typical alkali crust.

[Near N. W. cor. sec. 20, T. 9 N., R. 3 E.]

Constituent.	Per cent.	Constituent.	Per cent.
Ions:		Conventional combinations:	
Calcium (Ca).....	1.12	Calcium sulphate (CaSO_4).....	3.80
Magnesium (Mg).....	6.79	Magnesium sulphate (MgSO_4).....	33.65
Sodium (Na).....	20.18	Potassium sulphate (K_2SO_4).....	.70
Potassium (K).....	.31	Sodium sulphate (Na_2SO_4).....	57.19
Sulphuric acid (SO_4).....	68.58	Sodium bicarbonate (NaHCO_3).....	1.80
Chlorine (Cl).....	1.40	Sodium carbonate (Na_2CO_3).....	.56
Bicarbonic acid (HCO_3).....	1.30	Sodium chloride (NaCl).....	2.30
Carbonic acid (CO_3).....	.32		
		Soluble salts.....	48.30

The tests made show that, as a rule, there is not enough alkali in the upper 18 inches of soil to impair the growth of crops. The quantity of alkali increases with depth to 3 feet, below which the

content is nearly constant. An average of all the borings made places the salt content of the alkali soils as follows: First foot, 0.21 per cent; second foot, 0.39 per cent; third foot, 0.48 per cent; fourth foot, 0.48 per cent; fifth foot, 0.47 per cent; sixth foot, 0.47 per cent, and the average to a depth of 6 feet, 0.42 per cent. From this it will be seen that the quantity of alkali in the upper soil is not dangerous, but that the average amount in the soil is sufficient to be of some concern to the farmer. Under conditions of dry farming this alkali is of no particular danger, since the annual rainfall in this area is not sufficient to soak down into the lower soil and start an upward movement of the salts. With the application of irrigation water, however, there is danger that the distribution of the salts will be changed, with the final result that much of the land will contain an excess of alkali at the surface or within reach of the roots of crops.

Certain methods of handling the soil will, however, tend to keep the alkali in the subsoil beyond the reach of most crops in all areas, except where the conditions of drainage are least favorable. The quantity of water applied should be no more than will furnish the crop with the necessary moisture, and a very thorough cultivation of the soil should be practiced at all times. Thus very little water will reach the subsoil, evaporation from the surface will be largely prevented and the moisture will be held for the use of the crop. In the case of alfalfa and small grains, frequent cultivation of the soil can not be had, but the thickness with which these crops cover the ground will largely prevent the evaporation of the water.

On sloping lands the alkali is less apt to rise to the surface, since the water soaking into the lower soil will more likely come to the surface at lower levels. But for this reason care should be taken not to overirrigate the higher lands, otherwise the lower fields may have to be abandoned because of the increase of alkali.

If the quantity of alkali shall increase to such an extent that the cultivation of the land is no longer profitable, the only satisfactory remedy will be thorough underdrainage in connection with copious flooding. Since the general texture of the soils is heavy, and there is no subsoil drainage, the use of any temporary methods, as flooding or scraping the surface, will be only an expense and waste of labor. The drainage of these heavy soils will be slow and costly, but it is the only means of permanent reclamation. It can not be too strongly impressed upon the farmers that the continued productiveness of these soils can only be secured by the use of small quantities of water and a very thorough cultivation where the crop will permit, and it would be wise to underdrain the fields as soon as practicable as a preventive measure, whether the crops at the time are showing the effects of the alkali accumulations or not.

SUMMARY.

The Bellefourche area is situated in Butte and Meade counties, in the western part of South Dakota. The distinctive features are the winding valley of the Bellefourche River, the narrow valleys of tributary streams, and the high river terraces and rolling foothills forming the local watersheds. The largest stream is the Bellefourche River, which is fed by many tributaries. The regional drainage is good.

Bellefourche, the county seat of Butte County, is the principal town in the area. Other towns are Snoma, Vale, and Minnesela.

Until recent years this portion of the State was mostly an open stock range. The earlier settlers in this area were chiefly interested in the cattle industry, and farming operations were confined to very small fields. Native hay and oats or wheat, and occasionally some corn, were about all the crops grown. In recent years the acreage under cultivation has increased and a wider variety of crops has been grown. These include alfalfa, rye, barley, millet, potatoes, brome grass, vegetables, and some orchard fruits. There is a demand for farm products of all kinds, and the good railroad facilities give connections with outside markets.

The climate of the area, although subject to rather wide ranges in temperature and variations in rainfall, is well adapted to the growing of many different crops, particularly under irrigation. The average annual rainfall is sufficient to make dry farming profitable.

Most of the soils of the area are heavy, compact, and tenacious. The lighter-textured soils are confined mainly to the area south of the Bellefourche River. The surface drainage of the soils, with the exception of one type, is excellent.

The heavier soils are derived from the weathering of the Pierre shale formation or the reworking of this material by water. The lighter soils owe their formation to the action of streams draining the northern portions of the Black Hills.

An abundant supply of water for irrigation is available in the combined flows of the Bellefourche and Redwater rivers. Only a small part of the area is irrigated at the present time, but all of the lands will soon be placed under irrigation by the United States Reclamation Service.

Alkali is generally present in the soils north of the Bellefourche River. Over the larger part of the affected area the quantity in the soil is sufficient to become dangerous to crops when irrigation is practiced. Damage from the rise of alkali can be prevented or delayed by careful use of irrigation water and thorough cultivation, or by underdrainage. Once accumulations have taken place, reclamation

will be a difficult and costly process on account of the impervious nature of the soil and subsoil. Underdrainage and flooding will be necessary.

Gypsum is present to a greater or less extent in nearly all the soils of the area. It is the predominating salt and, with sulphate of sodium and sulphate of magnesium, forms the greater proportion of the alkali. No carbonates or black alkali occur.

SOIL SURVEY OF THE MINIDOKA AREA, IDAHO.

By A. T. STRAHORN and C. W. MANN.

DESCRIPTION OF THE AREA.

The Minidoka area is situated in the south-central part of a great stretch of country known as the "Snake River Plains" or the "Snake River Desert." It comprises about 146 square miles lying along the Snake River in the south-eastern part of Lincoln County and in the northern part of Cassia County. In shape it is roughly rectangular and is included within Rs. 22, 23, 24, and 25 E., and Tps. 8, 9, and 10 S.

The Snake River enters the area at the northeastern corner, and flows in a general southwesterly course, leaving the area at the southwestern corner. Nearly all of the area is located on the north side of the river. The small portion, about 12 square miles in extent, on the south side, occurs as a long, narrow body between the Southside Canal and the stream.

The northern and western boundaries are determined by an abrupt rise of lava rock above the surface. On the south and east the Southside Canal and the course of Snake River determine the limits of the area.

North of the river the surface is without any striking topographic features, except a few high sand dunes in the northeast and the high bench along the northern and western sides. Aside from a shallow,

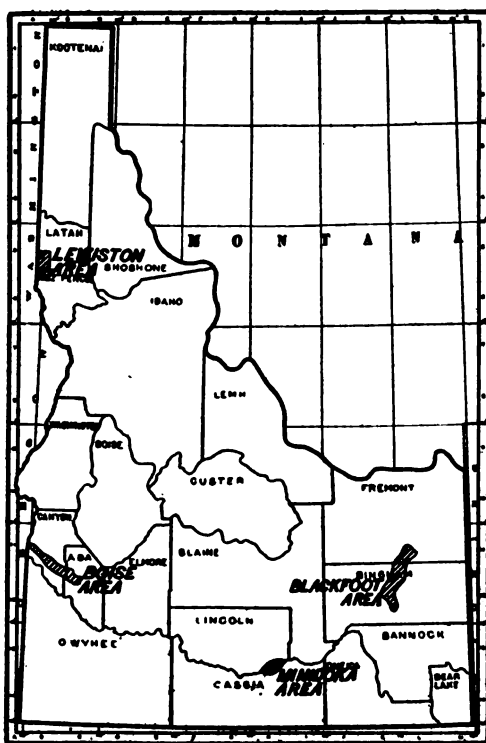


FIG. 31.—Sketch map showing location of the Minidoka area, Idaho.

poorly defined drainage course running through the central portion of the area, there is absolutely no system of surface drainage north of the river. The appearance of this portion is that of a rolling plain, with rounded knolls of wind-blown sand along the river, and occasional outcrops of black lava rock. At first sight the land south of the river presents the same appearance as the northern portion, but it differs in that there is a fair slope from the line of the canal toward the river, and at intervals there are more or less well-defined courses, which usually afford ample drainage.

The early immigrant trail across this section of the West ran from the town of Albion, near the southern State line, to Boise. Albion is about 25 miles southeast of Rupert, and is said to have been the first settlement in Idaho east of Boise. After the construction of the Central Pacific from Ogden westward cattlemen began driving their herds northward, and ranged them over this part of the State. After the construction of the Utah and Northern (now the Oregon Short Line) from Ogden to Butte more cattlemen came in, and a few ranch houses were built along the banks of Snake River. These, however, were few and far between, and until four years ago there were but three buildings within the area embraced by the Minidoka Project.

Shortly after the construction of the irrigation system started settlers began to move into the area in greater numbers, and three villages soon sprang up. From north to south these villages were Acequia (formerly Sherrer), Rupert, and Heyburn. Across from Heyburn, south of the river, is the town of Burley, on patented land, and promoted by a private corporation. Rupert, which is at present the largest town in the area, and located near the center of the project, is the headquarters of the Reclamation Service. Acequia and Heyburn are smaller villages, the former being near the northern boundary and the latter near the southern boundary of the project.

A branch of the Oregon Short Line, known as the Minidoka and Southwestern Railroad, was built across the area in 1904, in a southwesterly direction, passing through the three towns mentioned. This branch connects with the main line of the Oregon Short Line at Minidoka, and furnishes a ready outlet for the produce shipped. With the present railroad connections it is likely that the principal markets will be in the northeastern part of the State and in Montana and Wyoming. Should fruit prove well adapted to this section the markets farther east doubtless will be reached.

Wagon roads are either open or projected along each section line. So far no care has been given them except the removal of sagebrush. Where the soil is heavy and packs well the roads are in good condition, but on the lighter soils the material is loose and traveling is slow.

Although there are many substantial dwellings and barns on the farm units, there are many which are very crude and poorly built. These, however, are for temporary use, and in a few years will be replaced by better structures. Nearly all of the farms are well fenced.

CLIMATE.

The climate of this section of the State is arid and is characterized by a low annual precipitation, cold winters, hot summers, and a high percentage of cloudless days. The records of temperature and precipitation are very meager. The winters as a rule are open; in some years no snow falls before the latter part of December. In very exceptional years the thermometer may go as low as 25° below zero, but usually the minimum winter temperature is but little below zero. "Chinook" winds are frequent during the winter season.

The average annual temperature of several points along Snake River is as follows: Boise 50.4° , Pocatello, 46.9° , Blackfoot, 45.5° , Twin Falls, 48° , and American Falls, 46° F. Owing to the short time in which records have been kept, the average dates of frosts can not be exactly stated, but it seems probable that the date of the last frost in the spring is about May 1 and the first in the fall about the last of September. In the present year (1907) the first frost to affect crops occurred September 20.

Maximum temperatures of 105° in summer have been reported, but the usual summer heat is much less. The low humidity of the air tempers the extremes of temperature, and renders the climate endurable at all times.

The season of precipitation along Snake River covers the period of late winter and spring, rain usually falling until the 1st of June or a little later. With the exception of a short rainy period about the middle of November, very little rain falls except in the winter and spring months; such rains as do occur are light showers hardly sufficient to lay the dust. The annual precipitation at the different points along Snake River varies from 8 to 17 inches, and from the data at hand it seems likely that the average annual precipitation is about 12 inches.

The prevailing direction of the wind is from the southwest. Winds of sufficient violence to damage crops are rare. During the hot summer days dust storms sometimes occur, and electrical storms are frequent along the mountain ranges a few miles to the south, but rarely sweep across the area.

The data given below are taken from the records of the Weather Bureau stations at the towns named:

Normal monthly and annual temperature and precipitation.

Month.	American Falls.		Milner.		Minidoka Dam. ^a	
	Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.
	° F.	Inches.	° F.	Inches.	° F.	Inches.
January.....	25.4	1.15	28.5	0.91	24.7	1.26
February.....	26.4	1.22	31.6	1.22	29.4	1.23
March.....	35.1	1.66	38.7	1.62	31.2	2.13
April.....	45.4	1.35	47.5	0.77	48.2	1.07
May.....	53.4	1.56	55.9	0.74	54.4	1.50
June.....	61.8	0.66	61.9	0.97	59.8	1.62
July.....	69.7	0.52	73.0	0.07	74.0	0.22
August.....	69.3	0.43	71.9	0.32	71.0	0.94
September.....	58.2	0.64	63.5	0.16	62.5	0.06
October.....	47.1	0.89	47.4	0.22	50.0	0.17
November.....	35.3	1.26	37.2	0.71		
December.....	25.3	0.61	28.2	1.12		
Year.....	46.0	11.95	48.8	8.83		

^a The figures given for Minidoka Dam represent the temperature and precipitation for the year 1906 without departures from the normal.

AGRICULTURE.

The area surveyed occupies, as has been stated, a vast, rolling, treeless plain covered with a dense growth of sagebrush and rabbit brush, being part of what is known as the Snake River Desert. This stretch of rolling country is broken at intervals by benches and outcrops of black lava rock, which sometimes form a series of huge steps from one level of the plain to another. This apparently barren country held no attractions for the early adventurers or prospectors, and they passed it by for the more promising country to the west. Consequently, with the exception of the few ranches previously mentioned, no settlement was made in the area until the withdrawal of land by the United States Reclamation Service for the construction of the irrigation system.

Soon after the beginning of this work settlers moved in and took up the land under the project. As the land was densely covered with bushes and rain was often insufficient for crop production, it was a disheartening struggle for the settler to hold on until he could get water, and many abandoned the undertaking and moved to other sections. Many of the settlers, however, were better equipped and were able to clear their land and prepare it for irrigation.

It was the intention to have the irrigation system completed in April, 1907, but, owing to delays of one kind and another, water was not delivered until the early summer, when a sufficient quantity for

nearly 1,000 of the 1,208 farm units in the project was rendered available. Although a large number of the farm units had been filed on and occupied for at least two years, few more than 500 were prepared to receive the water, and owing to the location of some of these it was possible to deliver water to only 475. These, however, received an abundant supply.

On account of the lateness in the season when water was received, the generally poor condition of the ground, and the lack of knowledge of methods of irrigation by the farmers, the crop yields this season have been very low and are not regarded as a measure of the productiveness of the soil. According to acreage, the crops planted this season rank about as follows: Oats, wheat, barley, potatoes, alfalfa, and corn. At the time of writing this report (November, 1907) very little harvesting had been done, so that figures which will accurately represent the average yields obtained this year can not be stated. It would seem from the oats which have been thrashed that about 30 bushels per acre would be the average for this crop. Much of the crop, however, was not thrashed, but cut for winter feed. The yield of alfalfa was very small, as the crop was only seeded last spring and a light cutting obtained this fall. No estimates can be formed as yet for the yields of wheat, but a very large proportion of this grain, like oats, will be used for winter feed. Little of the corn reached maturity on account of the early frost. Of all crops grown this year, potatoes have made the best showing, and it would seem that a large proportion of this area is well adapted to their production. Not very much of the crop has been harvested yet, but yields of 150 to 200 bushels per acre are reported.

Judging from the growth and yields made even under the adverse conditions, it would seem that the soils of this area will prove well adapted to the growing of the crops mentioned. It will probably be found, however, that the profitable production of corn in this area will be somewhat difficult, not on account of soil conditions, but because cool nights and frosts will injure the plant before it matures. In view of this fact corn should be planted as early as possible and the varieties confined to those that mature early. It is believed, with good reason, that this area will prove well adapted to a wide variety of fruits. Many of the settlers have set out small orchards and some small fruits, all of which have made a healthy growth during the last season.

On the lighter soils of the area it will probably not be necessary to irrigate much before the 1st of June, while on the heavier soils crops will probably not require water until a somewhat later date.

The limited size of the farms (40 and 80 acres) will eliminate, as far as it is possible to do so, the necessity of hiring farm labor. It is thought that, except for hiring thrashing crews in the fall, the need

of additional labor will be met by the exchange of work by neighboring farmers.

The entire acreage within the Minidoka Project, except the usual sections of school lands and about 300 acres of patented land, is held by individuals under the homestead and reclamation laws. All of the land within a radius of $1\frac{1}{2}$ miles of the various town sites has been divided into 40-acre farm units. Outside of these boundaries the size of the farms has been made 80 acres, although along correction lines the farms may contain a little more or less than that figure.

At present the agricultural methods differ with the individual farmer, but as soon as a better knowledge of soil, crop, and climatic requirements becomes general more uniform methods of cultivation will prevail.

SOILS.

The underlying geological formation of the Minidoka area is lava rock composed of three or four strata, sometimes outcropping at the surface in the form of ledges, but more frequently found at depths ranging from 15 to 100 feet.

Above this lava bed is found a thick mantle of coarse black sand which extends upward to within 5 or 6 feet of the surface. This sand has been deposited by water action over the lava beds, being an alluvial deposit from the river at a former time. The material overlying this stratum is much finer in texture, and is of varying depth. It doubtless was also deposited by the agency of water at a later date.

To the wearing away of the immense lava beds a large proportion of the subsoils of the area owe their formation. To some extent this process has also contributed to the formation of the soils, in which, however, material derived from a wide range of rocks along the upper courses of the Snake River is present.

In the soil mass above the lava bed rock, the distinct stratification of material, varying from gravel to fine sand and silt, leaves no doubt as to the method by which the soil material has been deposited.

Along a portion of Snake River and the lava ledges there is a considerable area of soil formed by aeolian agencies, which has been indicated on the map as Yakima sand.

In this area the most irregular topography is represented by the extent of Yakima sand, in which the surface varies from high rolling dunes, outcrops of ledges of lava rock, and marked depressions with no drainage outlets, to areas which are only slightly rolling.

The Yakima fine sandy loam, next to Yakima sand, presents the greatest irregularity of surface, but in the area occupied by this soil the differences in the elevations between the knolls and depressions is not so pronounced, and stretches of fairly level land occur within this type. The Yakima sandy loam and the Yakima loam represent the most level portions of the area surveyed, although the surface here

and there is somewhat uneven. Where protected by the native vegetation there is little or no movement of the surface soil, but where the sagebrush has been removed, and to some extent on the unprotected sand dunes, the soils are affected by wind movement. The effects may be seen in the sagebrush adjoining cleared lands, where the winds of a single season have formed miniature sand dunes around the clumps of bushes.

The types of soil within this area belong to a series which has been previously recognized in other western areas.

Below are given the names and the actual and relative extent of the several types of soil mapped in the area surveyed:

Areas of different soils.

Soil.	Acres.	Percent.	Soil.	Acres.	Percent.
Yakima fine sandy loam.....	31,872	34.2	Yakima loam.....	12,736	13.6
Yakima sandy loam.....	29,760	31.9	Meadow.....	1,600	1.7
Yakima sand.....	17,344	18.6	Total.....	93,312	

YAKIMA SAND.

The Yakima sand consists of 40 inches to 6 feet of an incoherent yellowish or occasionally blackish sand, and in texture varies from a fine to a medium sand. When the type does not extend uniformly to a depth of 6 feet it is underlain by either a coarse black sand or by the lava bed rock. Along the northern edge of the area, and frequently just outside of it, the lava rock sometimes outcrops, and in places detached fragments of lava may be observed lying on the surface of the soil. Between the soil and the underlying black sand there is sometimes a thin layer of white compact material, usually a very fine sand. This, however, is not characteristic of the type.

On the north side of the river this soil extends in an almost unbroken body across the northern portion of the survey, and then along the north bank of the river southward for a distance of about 9 miles. Smaller detached areas occur along the course of the river, and at intervals throughout the survey. On the south side of the river the only considerable body of this soil lies above Montgomery's Ferry. Only a few detached areas are found on this side of the river.

The topography of the type is generally very irregular, consisting of numerous knolls or dunes of loose, shifting sand, frequently having an elevation of 20 feet above the more level portions of the type. The most level stretches lie south and east of Rupert. Along the river this soil terminates with an abrupt slope of 6 to 10 feet, which drops either to the water's edge or to low, small areas of overflowed land. The larger proportion of the type is above the water level of the present gravity irrigation canals, but will be irrigated at some future time by pumping.

The type has absolutely no surface drainage, but as the soil is loose and open in structure rain water passes readily through it, and even after unusually heavy storms finds its way to the depressions, where it soon passes below the surface.

This soil owes its origin to the sands of the bed of the Snake River, which are exposed during low water. The surface soil is made up of this material blown by the winds onto the adjacent lands, or carried for a considerable distance and deposited along the lava rim rock. The coarse black sand, lying below the wind-blown material, is an alluvial deposit from a former stream. The black color in this sub-soil is due to the presence of considerable quantities of particles of black or dark-colored lava, and occasionally portions of the surface soil are slightly colored by fine particles of this same material.

No alkali occurs within the area covered by this type.

The areas of Yakima sand are entirely treeless, but are usually covered with a good growth of sagebrush and rabbit brush. The areas so covered are stationary, but probably receive slight additions of wind-blown material; where the surface is uncovered the soil is subject to the action of the wind and is being slowly shifted.

No average yields can be given for this soil, as but little of it was prepared for irrigation or received water during the past season. It will probably be found well adapted to the growing of alfalfa, root crops, and fruits. Small grain may prove profitable if abundant water is available.

On account of the loose, incoherent nature of the soil, it will, when cleared of the native vegetation, be subject to the drifting action of the wind. This drifting is to be avoided if possible, as it will necessitate releveled of the land for subsequent irrigation and the possible relocation of the laterals. For this reason alfalfa is strongly recommended for as much of the land as can now be irrigated, as it will effectively hold the soil in place, and in addition will furnish organic matter for the use of future crops. Small fruits will also tend to hold the soil and return a profit to the owner.

It is also recommended that those portions of this soil lying above the present canals remain covered with the native vegetation until it is possible to irrigate by pumping. Fall plowing is to be avoided, as it will leave the soil open to the action of the winter winds.

The following table gives the results of a mechanical analysis of this soil:

Mechanical analysis of Yakima sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18001.....	Soil.....	0.1	9.5	16.7	61.9	8.5	1.4	2.6

YAKIMA SANDY LOAM.

The Yakima sandy loam consists typically of 18 to 40 inches of coarse sandy loam, underlain to a depth of 6 feet or more by a coarse black sand or occasionally by a very light-textured coarse black sandy loam.

The surface soil, except along contact with the Yakima sand, is usually compact and becomes somewhat heavier in the third and fourth feet. Quantities of small waterworn gravel may occur in the surface soil. The color is usually of a light brownish yellow, but darker areas are seen where the soil contains considerable quantities of fine particles of black lava rock. The structure of the subsoil usually shows prominent stratification of its constituents. Fine gravel nearly always is scattered through it, and in a few places forms the larger part of the soil mass.

This soil grades almost imperceptibly into the Yakima sand or the Yakima fine sandy loam, and the line of demarcation between it and these types is often vague.

The Yakima sandy loam is the most extensive soil in the area, the principal body lying in the center and extending eastward nearly to the dam. Other bodies of greater or less size were found.

The topography of this type presents no features strikingly different from the other soils mapped, except that it has a decidedly more level surface than the Yakima sand. Its most irregular surface features are usually found along the boundary of the Yakima sand, where the surface consists of low knolls and depressions. The remainder of the type is more level, though there is very little of this soil but will require leveling before irrigation.

The shallow drainage course which traverses this type affords at best only poor surface drainage, but the soil is rather porous, and storm waters soon find their way into the sandy subsoil, and are removed by subdrainage.

The surface layer is made up of material brought by the Snake River and its tributaries from distant sources and to a certain extent from weathered and disintegrated portions of lava rock. The coarse sandy subsoil is almost wholly derived from basaltic material. The surface material has been more or less modified by wind action.

The larger proportion of the type is free from harmful quantities of alkali, although traces of alkali may be observed in the smaller bodies. In a small portion of the type, east of Heyburn, some alkali is found, but the largest quantity in the soil in no case exceeded 0.40 per cent.

A heavy growth of sagebrush, rabbit brush, and in alkali areas greasewood, covers the entire extent of this soil. Some grass is found between the larger plants, but the growth is not extensive.

No satisfactory figures can be given for the crop yields made. On a very few fields, yields of oats were reported at 60 bushels per acre.

It is very probable that the yield of oats this year will be about 30 bushels per acre, but when cultural conditions are more favorable and the farmers are more experienced a much higher average yield may be expected. A considerable acreage of this soil was planted to potatoes. Little of the crop has yet been harvested, but judging from the few fields where the crop was dug, a yield of about 200 bushels per acre may be expected. From the thrifty growth of the plants, and the size, form, and quantity of the tubers, it appears that this soil will prove productive for this crop. Alfalfa has made a good growth for the first year, and will undoubtedly prove a paying crop eventually. The various small grains made a good growth, but for various reasons a large part did not fill out and the yield was light. A large amount of the grain was cut to provide winter feed for farm stock.

The soil has a loose texture, and aside from plowing and the subsequent leveling for irrigation, few cultural operations will be required. On this soil little advantage will be gained from fall plowing, and it is advised that this be omitted, as the uncovered surface will be damaged by the action of the winds.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil:

Mechanical analyses of Yakima sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18089.....	Soil.....	1.5	14.5	15.9	39.6	13.1	8.4	7.1
18090.....	Subsoil.....	3.2	20.4	18.9	40.9	5.4	6.3	5.1

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 18089, 1.84 per cent; No. 18090, 5.23 per cent.

YAKIMA FINE SANDY LOAM.

The Yakima fine sandy loam shows a considerable variation in the texture of the surface soil and in the depth of the coarse sand below the surface. Typically the soil consists of from 10 to 40 inches of a medium textured fine sandy loam, underlain by a heavier and finer textured sandy loam extending to a depth of from 50 to 72 inches, beneath which is found the usual bed of coarse black sand. Lava rock sometimes occurs within 6 feet of the surface, but this is not usually the case. The texture of the surface soil varies from a fine sandy loam to a very coarse sandy loam, and the subsoil from a fine light textured sandy loam to a heavy, compact, sticky phase in which the texture may be either fine or coarse. The surface soil is a light yellowish brown, while the subsoil varies from a light yellowish brown to almost white. The subsoil when exposed to the air turns

white or a light ashy gray. The sand underlying this subsoil is of the same texture as that underlying the other soils of the area.

The principal body of this type is found between Rupert and Heyburn and extends westward to the limits of the area. Smaller bodies occur east of Rupert and along the northern edge of the area and south of the river. Next to the Yakima sandy loam this type is the most extensive soil in the area.

From an irrigation standpoint only a very small portion of this type could be classed as level land, the surface being usually somewhat rolling, and in the southern portion of the area frequently very uneven, caused by numerous depressions, occasionally 8 to 10 feet deep.

Aside from a narrow strip adjoining the drainage course, there is no system of surface drainage. The texture of the soil usually favors a ready movement of water through the subsoil, and water never remains long on the surface. In the depressions along the southern portion of this type the soil is somewhat heavier and does not permit ready percolation. Consequently these depressions will probably contain seepage water throughout the larger part of the irrigating season.

The bed of coarse sand in the subsoil of this type is doubtless the same in origin as that underlying the other soils. The upper soil seems to have been formed by alluvial agencies, which have also caused the deposition of the finer heavy material of the sticky subsoil. Wind action probably has modified the surface soil, and to a certain extent probably aided in building it up. Knolls of wind-blown sand and of Yakima sandy loam occur at intervals throughout it. The subsoil above the black coarse sand contains traces of alkali through its entire body, but only in the southern portion was there found a sufficient amount of alkali to necessitate mapping. In the alkali areas the surface foot is usually free from alkali. Below 12 inches the amount of soluble material usually increases until the bottom of the fourth foot is reached, and below this there is a decreasing quantity of soluble salt. When the sand is within 6 feet of the surface there is no alkali in the lower section. The usual quantity of alkali in this soil averages 0.20 to 0.40 per cent, there being only three small areas where the concentration was greater.

The Yakima fine sandy loam, except for a scattering growth of low willows along the edge of the river, is treeless. The native vegetation consists of sagebrush, rabbit brush, and greasewood.

On account of irrigation for only part of a season, and late cultivation, it is hardly possible to give average yields. All of the crops observed seemed to be doing well, but from lack of a supply of water throughout the whole season the yields will be light. This soil will probably be found well adapted to the various small grains, root crops,

alfalfa, and fruits suited to the climate. In the alkali area, alfalfa, timothy, root crops, oats, and sorghum will doubtless succeed better than some of the other crops.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Yakima fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18098, 18101...	Soil.....	0.5	6.2	8.1	45.8	22.0	10.1	7.3
18099, 18102...	Subsoil.....	.2	3.6	4.2	21.7	19.6	40.0	10.9
18100, 18103...	Lower subsoil..	4.1	19.4	17.1	48.1	5.5	3.4	2.5

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 18099, 22.30 per cent; No. 18100, 3.86 per cent; No. 18103, 5.77 per cent.

YAKIMA LOAM.

The Yakima loam to a depth of 4 inches is a medium-textured sandy loam, underlain by a heavy silty loam extending to a depth of 4 to 6 feet. Where the latter does not extend to 6 feet it is underlain by a coarse black sand. When the surface soil is a sandy loam it has a light porous structure and is light yellowish brown in color. When the sandy loam is absent from the surface the color is a light brown with a slight reddish cast. Below the surface the color varies from a dark brown, through a light reddish brown, to dark gray. The texture of this soil is a fine silty loam at the surface, which may continue to a depth of 6 feet or until the sand is encountered, though more usually the soil becomes heavier below and grades into a light clay loam. In a few places, particularly in the northern portion of the area, the subsoil was nearly a clay. The lower subsoil of black sand is identical with the sand underlying the other soils of the area.

The principal body of this type begins at a point about 1 mile west and a little north of Rupert and, widening out, extends to the western edge of the survey. Several smaller bodies occupy depressions along the northern portion of the area, and a few detached bodies are found southwest of Rupert.

The larger part of the Yakima loam is level or only slightly rolling, while a smaller portion is rough and precipitous and not very valuable for agricultural purposes. This latter phase occurs along the northern and western edges of the area, where the lava rock approaches the surface and where one or two steep knolls rise out of the more level portion of the type. One of the depressions in the northern portion of the area, in sec. 10, T. 95, R. 23 E., is below the level of Snake River.

There is no system of surface drainage in this type, and on account of the heavy nature of the subsoil movement of water downward is

slow. Especially in the northern part, where in depressions the soil is more compact, is this true, and water usually stands in these depressions several months in the year.

It seems probable that the lighter surface soil is of aeolian origin, while the heavier portion is due to alluvial and possibly lacustrine agencies.

The larger proportion of the Yakima loam was once covered by a body of water having little movement and carrying only fine material in suspension. The smaller bodies in the depressions were probably formed in much the same way, although since the removal of the water more or less soil material has been added by the wash from adjacent higher lying soils.

This type is free from any harmful quantities of alkali. Traces of it are found throughout the greater part of the subsoil, but the alkali content of the soil is small. The banks of the canals are frequently thinly coated with alkali washed out of the soil by the irrigation water.

With the exception of the depressions which support a thick stand of grass, the native vegetation on this type consists of a heavy growth of sagebrush and rabbit brush. The type is treeless.

This soil, like the others, was not prepared for crops, although enough water was delivered to most of it. Where the land was tilled the crops made as good a growth as could be expected under the adverse conditions. It will doubtless be found that this soil will require fewer applications of water than the other soils and that water will not be required on the land so early in the spring. This type is probably adapted to alfalfa, small grains, and root crops. Fruits ought to do well on it, but the lighter soils will doubtless prove to be better suited to their production. Root crops will do well here in all probability, but potatoes will yield better on the lighter soils.

The larger part of this type may be plowed in the fall, if desired, as it is not so liable to be affected by the winter and spring winds. However, the areas with light surface soil should remain covered with stubble.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Yakima loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
18002, 18006...	Soil.....	0.4	4.5	5.1	17.9	21.0	38.1	13.1
18003, 18008...	Subsoil.....	.0	1.1	2.3	15.9	11.4	44.2	24.7
18004, 18007...	Lower subsoil..	.4	20.7	20.9	41.4	7.7	4.9	4.1

MEADOW.

Meadow varies in texture from a heavy clay loam, 6 feet or more in depth, to a few inches of heavy soil underlain by a bed of coarse river sand and gravel. Between these extremes it is possible to find all gradations in structure and texture, with no regularity in the arrangement of the different classes of material.

Meadow occupies the smallest extent and is the least important of the soils recognized. Its long, narrow stretches along the river in some places are overflowed when the stream is high. The water table is usually within 6 feet of the surface, and the entire type is poorly drained.

This soil owes its formation to the action of the river at high-water stages, the varying carrying power of the stream resulting in the erratic distribution of soil material.

A considerable proportion of this type contains alkali, with an average concentration of 0.40 to 0.60 per cent for the surface 6 feet of the soil section. On the south side of the river all of this type contains traces of alkali.

The native vegetation consists of a low growth of willows along the bank of the river, sagebrush, greasewood, and at times a heavy growth of grass. At present none of this type is cultivated, and a considerable portion of it contains too much alkali for the growing of any but the more alkali-resistant plants. As it is overflowed yearly, it will be difficult to irrigate, as the ditches will require rebuilding each spring. It is suggested that its most profitable use will be for grass.

IRRIGATION.

Water for irrigation in the Minidoka area is obtained from the Snake River. This stream has its source in the high mountains of north-eastern Idaho and northwestern Wyoming, and the melting snow in these elevations supplies water throughout the year. The river is lowest throughout the late summer months, but increases in volume until the maximum flow is reached late in May or early in June. Gauging stations have been kept by the Geological Survey for a number of years, and the average minimum flow has been found to be about 4,000 second-feet and the average maximum about 30,000 second-feet. Minimum flows as low as 1,800 second-feet and maximum flows as high as 39,000 second-feet have been reported.

The water of Snake River is of very good quality for irrigation. Tests made in the field showed that the amount of soluble material was between 30 and 40 parts in 100,000 parts of water. Analysis shows the exact amount of soluble material to be 111.3 parts for 100,000 of water. The sample analyzed was taken in October, when the river was near its lowest stage, at which time the soluble content was probably highest.

The irrigation enterprises along the Snake River prior to the construction of the present system were confined to a few small areas in the vicinity of the ranch houses, water being lifted to the land by large water wheels. After the construction of the irrigation system by the United States Geological Survey and other systems to the westward, these wheels could not operate on account of a lack of current in the river and they are not now used.

About 12 miles east and a little north of Rupert the Snake River has cut through a stratum of lava rock and made a narrow gorge about 50 feet deep. At this point in the river the Reclamation Service constructed a concrete sluiceway, spillway, and a dam made of concrete, rock, and earth, which checks the flow of the river and raises the water level 40 feet. The water is led onto the land from the dam by a canal on each side of the river.

The total flow of the river can not be used for the irrigation of the project and adjacent lands, as there are prior water rights on the lower Snake River. To insure a plentiful supply for these prior rights and for the present Minidoka Project, taking into consideration also its possible extension, a dam is being constructed across the outlet of Jackson Lake, one of the tributaries of the Snake River, in Wyoming, where a large volume of water will be stored. This will be used during the summer months to increase the flow of the river. Provision has been made at the dam, at the head of the project, for the future installation of water-power plants, which will furnish electricity for lighting purposes and for power pumps to be used in extending the irrigation system to the higher and more remote areas.

The main canal on the north side of the river is about 35 miles in length, and has a capacity at the headgates of 1,060 second-feet. The south side canal is about 8 miles long, and has a capacity of about 170 second-feet. This latter canal is so constructed that it may be enlarged in the future, as it is intended to irrigate a considerable area south of the end of the present canal by pumping.

The irrigation system of the Minidoka Project was constructed under the terms of the Reclamation Act, by which the settlers agree to return the cost of the system to the Government in ten annual payments. In addition to these payments, there is an annual fee for maintenance. The cost to the settlers in this project is \$22 per acre, and a maintenance fee of 40 cents per acre each year. When all payments have been made, the system is to be turned over to the people by the Government, and is to be managed by them. The total area which can be irrigated by this gravity system of canals is placed at 71,348 acres. It is estimated that this area may be nearly doubled by means of pumping.

There are as yet no generally accepted methods of irrigating in this area. The water was turned into the canals for only a few months of the past season, and the settlers followed their own ideas in applying

it. The quantity necessary for the successful growing and maturing of crops will probably be found to vary considerably with the soil. On the lighter soils a relatively large quantity will be required, as some of it will pass down through the soil beyond the reach of the crops. The irrigated portions of the Yakima sand will probably require the largest quantity and the Yakima loam the least. No measurements have been made of the rate of seepage from the canals, but it must reach a very high figure, as the bottom of many of them is within a short distance of the underlying coarse black sand, and probably is a contributing cause to the rise of ground water in the adjacent soils.

It has been suggested that the seepage into the larger sinks might be used for irrigating the higher lands by pumping. It is possible to irrigate in this manner, but the use of the seepage water must be carefully watched. It would be better to use water directly from the canals for this purpose.

The soil throughout the northern portion of the area is free from alkali, and water seeping into sinks located there will be of good quality; but it is doubtful if the water will be found suitable for irrigation in the southern portion after the first year or two. The subsoil in this portion contains alkali, sometimes in considerable quantities, some of which will be carried into the sinks by the seepage. If care is not used, therefore, much damage may be done by applying this seepage water to the land.

Since irrigation began the ground water has risen to a higher level and is a matter of concern. Before water was turned into the canals the level of the ground water was from 15 to 40 feet below the surface, but after applications had been made the water table rose to within 9 feet of the surface in some places, and at the time the gates were closed the average level of the ground water was about 20 feet below the surface and has since been steadily falling. The amount of water applied to the land must be carefully regulated or considerable loss will result through the submergence of the roots of growing crops and a consequent diminution of yields.

Drainage in this area to remove the excess of ground water would be very expensive and should be avoided if possible. The success of irrigation will depend upon whether the porous subsoil will be able to lower the level of the underground water, during the winter season, to a sufficient depth so that the succeeding season's irrigation will not raise the water to a dangerous height.

ALKALI.

The alkali is confined to a narrow irregular strip of land in the southern part of the area and to a small outlying body about 1 mile east of Heyburn. Traces of alkali exist in the soil joining the main body of

alkali in places along the river and in portions of the soil west of Rupert, but the quantities are not sufficient to warrant mapping.

The origin of this alkali is somewhat uncertain, but it seems that its accumulation is due to a rather compact subsoil which has retarded underdrainage. The precipitation is not sufficient to permit the rain water to reach and percolate the heavier subsoil, and the soluble material has been slowly leached out of the surface soil and deposited at a point representing the lowest depth of percolation.

Qualitative tests of the alkali in the field show that it is made up largely of sulphates and bicarbonates. No black alkali was encountered by the party making the survey.

The amount of soluble salts in the larger part of the alkali district averages 0.20 to 0.40 per cent for the surface 6 feet of soil. Two or three small areas of alkali with a concentration of 0.60 to 1 per cent were found, as well as two others in the lowlands along the river containing 0.40 to 0.60 per cent.

The larger part of the alkali in the soil occurs below 20 inches and above 48 inches. Outside of these limits the soil is nearly always free from soluble material, and in only a few cases was the soil below 4 feet found to contain alkali.

Considering the quantity of alkali in the soil, there is only a very small portion of the area where growing plants might be injured. It is not unlikely, however, that in future years some trouble may be experienced with lands now shown to contain alkali through a rise and concentration of the salts at or near the surface. On account of the lack of natural drainage facilities considerable trouble will be experienced in removing the alkali when it becomes dangerous. A few of the farms near the river may be drained without much expense, and where the coarse sand is near the surface the alkali may be removed by the downward percolation of water, but in a large number of cases there is no ready outlet for drains and the reclamation of these lands will be a heavy expense.

SUMMARY.

The Minidoka area comprises about 146 square miles of the rolling lands bordering Snake River in southern Idaho.

Aside from a shallow, poorly defined drainage course through the central portion of the area there is no system of surface drainage. The gradient of the drainage course is very low. The surface features consist of numerous knolls, ridges, and depressions. The greatest elevations occur along the northern boundary of the area near the river.

The settlement of the area dates approximately from the beginning of the construction of the present irrigation system, about three years ago. The area now supports a population of about 4,500, has

three towns and railroad connections with the Oregon Short Line at Minidoka, Idaho.

Markets for the produce grown in the area are assured in Idaho, Montana, and Wyoming, and for fruits in the outlying States.

The climate is arid, and is characterized by low annual precipitation, rather high winds, hot summers, cold winters, and few cloudy days. In average years frosts may be expected in the spring until early May and in the fall about the 1st of October.

The agricultural development of the area began with the present year, and little knowledge, therefore, is to be had concerning the capabilities of the soils. All of the crops in the area made excellent growths considering the adverse conditions.

The relative acreage of crops planted the past season is about as follows: Oats first, then wheat, barley, potatoes, alfalfa, and corn. It seems probable that the cultivation of all these crops will prove profitable, with the exception of corn, which will be in danger from fall frosts in average years. Fruit, particularly apples, prunes, plums, and small fruits, will yield fairly well, and will probably be one of the important products of the area.

The farms are of 40 and 80 acres in size, and are held by the settlers under the homestead law.

The texture of the soils of the area varies from wind-blown sand to a silt loam, the larger proportion being made up of two sandy loams. The upper mantle of soil extends to an average depth of about 5 feet, underlain by several feet of coarse black river sand. Outcrops of lava occur along the northern boundary and on the south side of the river, but do not affect to any great extent the area of irrigable land. The soils are largely free from alkali, except those occupying the long, narrow strip bordering the river in the southern part of the survey. No black alkali was encountered.

Water for irrigation is taken from Snake River and is diverted by means of a dam at the eastern extremity of the area. There is an abundant supply of water not only for the present project, but for an extension of irrigation to the higher lands and more remote areas by pumping. The quality of the water is excellent for irrigation.

The irrigation of the area during the past season has caused a considerable rise in the level of the ground water. Unless care is taken in the quantity applied, a considerable acreage is in danger of becoming damaged by the high water table.

The cost to the settlers of land located in the area, under the terms of the reclamation act, is \$22 an acre, which is to be paid in ten annual installments, together with a maintenance fee of 40 cents per acre each year.

SOIL SURVEY OF THE COLUSA AREA, CALIFORNIA.

By MACY H. LAPHAM, A. T. SWEET, A. T. STRAHORN, and
L. C. HOLMES.

DESCRIPTION OF THE AREA.

The Sacramento Valley, 250 miles in length and from 20 to 60 miles wide, consists of that portion of the great central valley of California drained by the Sacramento River and its tributaries, chief among which are the American, Bear, Feather, and Yuba rivers. It is flanked on the east by the foothills and well-forested



FIG. 82.—Sketch map showing location of the Colusa area, California.

slopes of the Sierra Nevada Mountains, a region of heavy precipitation and the source of many perennial streams. On the west it is bordered by the less elevated ridges of the Coast Range, the higher summits of which attain an elevation of some 7,000 feet, and by numerous minor parallel foothill ridges and stream valleys. From the Coast Range, however, no important perennial streams issue.

At the north the Coast and Sierra Nevada ranges coalesce and culminate in the lofty peak of Mount Shasta, more than 14,000 feet in elevation. The Sacramento is the largest stream in the State, being navigable to light-draft river boats from its mouth to Red Bluff, at the head of the valley, a distance of more than 200 miles.

With an area of more than 2,500,000 acres, mainly of gently sloping valley plains and rich alluvial bottom lands, this valley is one of the most prominent physiographic and important agricultural sections of the State. Of this great area, however, about 400,000 acres consist of swamp and overflow lands, at present of use only as pasture during the dry season, but capable of reclamation by drainage and proper protection from floods, while over a great extent of the remaining portions, considering the favorable climatic conditions, the opportunities for irrigation, and the natural fertility of the soil, very little development has taken place.

The Colusa area consists of a section of the north-central part of the western half of the valley, in all about 756 square miles, extending from the lower foothills on the west to the Sacramento River on the east, with a small additional area on the eastern side of the river. The area has a width of about 17 miles and a length from north to south of about 46 miles. It is covered by sheets A, B, C, and D of the Sacramento Valley series of topographic maps^a recently issued by the United States Geological Survey, which were used as base maps in the preparation of the soil map, the scale being reduced to the regular 1-inch scale.

With the exception of a narrow strip about 2½ miles in width along the northern margin of the area, falling within the limits of Tehama County, and a small area in Butte County occupying the northeastern corner and lying east of the Sacramento River, the area surveyed lies within the counties of Glenn and Colusa. It covers, in the northern part, the territory embraced within the proposed Orland unit of the Sacramento Valley reclamation project; a large area of the Sacramento River bottoms, in which the beet-sugar industry is being developed; and to the south a great tract of irrigable land adjacent to the Central Canal irrigation system, and a considerable extent of rich river-bottom lands partly devoted to dairying and to the growing of alfalfa and fruit.

Stony Creek, having its source in the higher peaks of the Coast Range to the west, after flowing northward for some distance enters

^a These surveys were made in cooperation with the State of California. The maps or sheets are published upon the scale of 1 inch to 31,680, or practically 2 inches to 1 mile. Because of the large scale they show topographic and drainage features in considerable detail and should be in the hands of every farmer or other person interested in drainage or irrigation in this section of the Sacramento Valley. The sheets can be purchased at the trifling cost of publication by addressing the Director of the U. S. Geological Survey at Washington, D. C.

the area at a point about 4 miles northwest of Orland. It traverses the area in a southeasterly direction as a wide, shallow stream of gravelly bed and low and often poorly defined banks, entering the Sacramento River near Monroeville. The extreme northwestern part of the area, lying north from Stony Creek, consists of a somewhat elevated valley plain much dissected by minor creeks having their sources in the foothills to the west.

Southward from Stony Creek the western margin of the area consists of the lower rounded foothills, culminating farther west in a series of ridges parallel to the Coast Range. These lower hills are frequently cut by narrow fertile valleys drained by minor creeks, and, except along the southwestern margin of the area, the slopes of the hills are not often sufficiently steep to preclude cultivation and the use of farm machinery. Rock outcrop occurs only as a few areas of limited extent in the northwestern part of the foothill belt, but becomes much more frequent to the south and is indicated upon the soil map by the proper symbol.

From the base of the foothills and dissected plain the valley extends to the Sacramento River bottoms to the east, covering by far the greater part of the survey as a gently sloping or slightly undulating plain, traversed by frequent minor draws or intermittent water courses, and usually treeless, except in the vicinity of streams, where willow, cottonwood, oak, or other timber may occur. Prominent among the minor streams draining this part of the area may be mentioned Willows Creek with its north and south forks, French, Wilson, Logan, Hunters, Funks, Lurline, Glenn Valley, and Freshwater creeks. Such streams, however, rarely reach the Sacramento River, but disappear in the lower valley plains of deficient drainage. The surface of the valley plain is generally smooth, although it is sometimes marked by minor gently rounded ridges, knolls, "hog-wallow" mounds, or by shallow depressions or sinks, forming intermittent lakes or ponds during the rainy season, or occasionally by small gullies. The general slope of the plain ranges from about 20 or 25 feet to the mile at the base of the hills to about 5 feet or less to the mile upon the flatter and poorly drained section in the southeastern part of the area. The total fall from west to east across the valley plain between the base of the foothills and the river or the basin of minimum elevation is in general from 100 to 125 feet.

In places, particularly in the northern part of the area, the valley plain extends to the Sacramento River, the stream flowing in a well-defined channel separated from the plain by steep banks or low bluffs. Usually, however, the river is bordered by a strip of bottom land from one-fourth mile to 3 miles in width. These bottom lands in the southern part of the area have been built up by long-continued deposition of river sediments to a considerable height above the

adjacent lower valley plain, forming at a distance of a few miles from the river, where the slopes of the valley plain and of the ridge occupied by the river meet, a broad, shallow trough or basin occupied by shallow ponds or marshy areas or traversed by sloughs.

This well-defined basin or trough extends throughout the lower half of the area, being known in the southeastern part as the Upper Colusa Basin, and continues south beyond the boundary of the area. Into this basin of deficient drainage much of the water from the foothill streams during the winter rainy season and from the occasional overflow of the river finds its way. A great deal of this water is retained in the lower depressions or sinks and only dispelled by evaporation during the long summer season.

The surface of the bottom lands is often uneven, being interrupted with ridges, slight terraces, and mounds, or cut by sloughs or other erosions. These lands when not protected by levees are often overflowed during flood periods, during which the character of the river banks is frequently changed with the formation of new channels and sand and gravel bars by the shifting currents. In the vicinity of the river bottoms the valley oak and sometimes the blue oak appears as large and magnificent isolated specimens, or in beautiful groves, while upon the lower-lying lands a heavy growth of willow, sycamore, cottonwood, and other trees of the river bottoms often occurs. These are often mingled with a dense undergrowth of brush, blackberry vines, and wild grape.

The population of the Colusa area is essentially agricultural. It is of cosmopolitan character, the French and German races and the early pioneers from Missouri and the adjacent States of the Middle West, with their descendants, being liberally represented.

Owing to the extensive system of agriculture generally practiced, involving the dry farming to grain of large tracts, each supporting but a single family and a few laborers, and to the limited number of small irrigated farms, the population of the farming districts is generally sparse. Glenn County, according to the census of 1900, had but 5,510 inhabitants. At the present time, however, in the vicinity of the Sacramento River bottom lands the population in both Glenn and Colusa counties is undergoing considerable increase by immigration.

Colusa, with a population of about 2,000, the county seat of Colusa County and situated near the southeastern corner of the area and 140 miles distant from San Francisco, is the largest town of the area, followed by Willows, the county seat of Glenn County. Hamilton City, a new town situated near the Sacramento River, in the northern part of the area, is the seat of a beet-sugar factory. Orland, Germantown, and Maxwell are important shipping points located on the San Francisco-Tehama line of the Southern Pacific Railroad.

The first is located in the midst of a small but promising irrigated section. Other small rural settlements and post-offices are scattered along the river and are generally connected by daily stage with one or more railroad points. The larger towns are usually provided with well shaded and well laid out streets, electric lights, graded schools, telephone communication, substantial public buildings, and other modern improvements.

The main country highways are usually well graded, graveled, and kept in excellent condition. In the more sparsely settled districts, however, the condition of the roads during the rainy or winter season is less satisfactory. In addition to the San Francisco-Tehama line of the Southern Pacific system, railroad transportation is afforded by standard-gauge branch lines extending from Willows to Fruto, a small town located in the foothills to the west of Willows, and from the main line near Orland to Hamilton City, the latter branch being of recent construction. A recently completed short line also connects Hamilton City with Monroeville. This is at present used only for hauling beets or other freight, but is a section of a projected electric line connecting Redding, situated some distance above the head of the valley, with various valley points. In addition, connection with the Southern Pacific main line is had at Colusa Junction, over the Colusa and Lake Railroad, a narrow-gauge line extending from Colusa to Sites. The latter is a small town lying in the foot-hills northwest of Maxwell and an important shipping point for sandstone rock.

Other proposed steam and electric lines will connect Orland, Hamilton City, Jacinto, and the various river settlements and landings with the adjacent towns of Colusa, Corning, Chico, etc. Water transportation is afforded by Sacramento River steamers and a considerable part of the freight billed to the towns of the area is shipped in this manner, being hauled in wagons from the nearest river landing. This has a tendency to regulate freight rates generally. Grain warehouses are maintained at nearly all important river landings, railway towns, and sidings, while local markets for considerable fruit, vegetables, and truck crops are afforded by the near-by valley towns. The creation of a more important trucking and green-fruit industry would, however, call for increased facilities for fast freight and express shipment. In addition to local demands, good markets are available for poultry and dairy products, vegetables, hay, and general farm products in the mining towns of the north, in Sacramento, and in San Francisco and adjacent cities.

CLIMATE.

The climate of the Sacramento Valley is characterized by a dry and a wet season, the former coinciding with the summer and the latter with the winter.

The mean annual temperature, as shown by the records of the U. S. Weather Bureau, ranges from 60° to 65° F., being at Red Bluff, situated at the head of the valley and about 45 miles north from Willows, 62.5°; at Sacramento, 88 miles by rail southeast from Willows, 60°; at Chico, on the eastern side of the valley and 22 miles nearly directly east from Orland, 63.8°; at Orland, 65.3°; at Colusa, 60.9°; at Williams, just below the southern boundary of the area, 63.6°, and at Willows 63.5° F. The maximum temperatures are reached during the months of July and August, during which period excessive temperatures ranging from 110° to 115° F. are occasionally recorded, the usual maximum being 110°. The nights are, however, usually cool, there being a daily range in temperature during the hot months of 25° to 30°. Light frosts are of frequent occurrence during December and January, but minimum temperatures of less than 25° are rarely recorded, the usual minimum being about 28°. At Red Bluff the absolute maximum and minimum temperatures recorded since 1878 are 114° and 18° F., respectively.

The dates of first and last killing frosts at Red Bluff for the period 1897-1900 and for 1903, and at other valley points for the year 1899, are given in the following tables:

Dates of first and last killing frosts at Red Bluff.

	Last in spring.	First in fall.		Last in spring.	First in fall.
1897.....	Mar. 30	Dec. 20	1900.....		Dec. 30
1906.....	Mar. 18	Dec. 9	1903.....	Mar. 9	Dec. 7
1899.....	Feb. 7	Dec. 9	Average.....	Mar. 9	Dec. 15

Dates of first and last killing frosts for the year 1899 at Chico, Davisville, Dunnigan, Fruto, and Willows.

Stations.	Last in spring.	First in fall.
Chico.....	Mar. 30	Dec. 12
Davisville.....	Feb. 7	Dec. 19
Dunnigan.....	Feb. 7	Dec. 19
Fruto.....	Mar. 9	Nov. 23
Willows.....	Apr. 26	Dec. 13

In 1903 the last killing frost in spring at Colusa occurred January 28 and the first in the fall December 4.

Additional data from Water-Supply and Irrigation Papers, No. 86, entitled "Storage Reservoirs on Stony Creek, California," published by the United States Geological Survey and bearing upon temperature, precipitation, condition of sky, and direction of wind for the period 1897-1901 at Willows, Orland, and Corning, the

latter station situated 12 miles north from Orland, are given in the following table:

Climatological data for Corning, Orland, and Willows.

Station.	County.	Elevation (feet).	Year.	Temperature (°F).				Precipitation (inches).				Sky.				Prevailing direction of wind.	
				Annual mean.	Highest.		Lowest.	Total for year.	Greatest monthly.	Month.	Total snowfall.	Rainy days.	Clear days.	Partly cloudy days.			
					Degrees.	Date.									Degrees.		Date.
Corning..	Tehama.	277	1897	61.2	110	Aug. 19	27	Dec. 22	16.54	5.09	Feb.	0	.....	.....	.....	.....	
			1898	69.7	112	June 25	23	Dec. 11	.....	.....	.....	5	.....	260	0	105 S	
			1899	62.2	110	July 18	25	Feb. 4	27.72	8.13	Jan.	0	44	228	0	137 N	
			1900	63.1	110	July 19	32	Dec. 31	21.55	4.61	Jan.	0	51	213	8	144 N	
			1901	63.8	108	June 28	26	Jan. 1	20.66	6.09	Jan.	3.5	41	227	0	138 N	
Orland...	Glenn ..	254	1897	64.9	110	Aug. 19	27	Dec. 22	14.14	4.01	Feb.	0	.....	.....	.....	.....	
			1898	65.6	118	Aug. 12	26	Jan. 12	7.93	3.64	Feb.	0	25	229	4	132 N	
			1899	64.4	115	July 19	26	Feb. 4	22.41	6.98	Jan.	0	65	195	3	167 N	
			1900	62.0	112	July 19	29	Dec. 31	18.40	4.61	Nov.	0	60	200	1	164 N	
			1901	65.0	116	Aug. 3	24	Jan. 1	17.86	5.14	Feb.	1	40	.....	.....	N	
Willows..	Glenn ..	132	1897	.....	105	June 30	32	Dec. 20	10.85	4.26	Feb.	0	.....	.....	.....	.....	
			1898	64.8	112	Aug. 12	30	Dec. 30	6.94	2.46	Feb.	0	20	273	4	88 N	
			1899	63.0	115	July 24	32	Feb. 2	19.15	6.56	Jan.	0	46	250	0	115 N	
			1900	66.3	106	July 7	35	Dec. 31	14.28	4.37	Nov.	0	42	233	9	123 N	
			1901	67.2	109	Aug. 3	30	Jan. 1	16.54	3.88	Feb.	0	39	255	0	110 N	

The normal monthly and annual temperature and precipitation, as published by the United States Weather Bureau for Orland, Colusa, Willows, and Williams, are given below:

Normal monthly and annual temperature and precipitation.

Month.	Orland.		Willows.		Colusa. ^a		Williams.	
	Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.
	° F.	Inches.	° F.	Inches.	° F.	Inches.	° F.	Inches.
January.....	47.6	3.26	45.2	3.29	47.2	2.62	46.1	2.79
February.....	51.2	2.08	46.8	1.93	51.2	1.98	50.0	1.86
March.....	55.7	2.17	54.6	1.66	56.8	2.98	54.6	1.59
April.....	62.4	1.41	60.3	1.34	60.0	1.42	61.1	1.09
May.....	70.4	.98	68.5	.72	62.2	.61	69.3	.62
June.....	78.7	.42	76.9	.18	70.5	.51	78.1	.25
July.....	86.4	.02	82.9	.00	77.4	.00	83.5	.00
August.....	84.2	.02	81.6	.04	75.3	.00	81.0	.06
September.....	76.7	.35	75.6	.21	70.5	.59	74.2	.28
October.....	66.4	1.12	65.2	.99	62.6	1.01	64.5	.68
November.....	52.6	2.08	54.8	1.86	52.6	1.84	54.0	1.26
December.....	47.9	3.10	47.2	3.26	44.8	3.10	47.2	2.43
Year.....	65.3	17.01	63.5	15.48	60.9	16.61	63.6	12.90

^a The temperature for Colusa is for the year 1905 without departures from the normal.

Further data from the same source give the average annual precipitation at other west side valley points as follows:

	Inches.
Davisville, Yolo County	16.55
Woodland, Yolo County	17.74
Dunnigan, Yolo County	19.10
Corning, Tehama County	20.79

At Sacramento, Knights Landing, and Tehama, situated on the Sacramento River, the average annual precipitation is given as 19.41, 18.32, and 18.51 inches, respectively. At Red Bluff, at the head of the valley, the average annual precipitation is 26.11 inches, and at Chico and Vina, on the eastern side of the valley, it is given as 22.44 and 20.68 inches, respectively. Comparison of the above tables shows that the average annual precipitation at Chico exceeds that of the west side points by from 1.65 to 6.96 inches, the rainfall being generally greater throughout the eastern side of the entire interior valley than upon the west side. The average annual precipitation at Willows and at Williams is also seen to be lower than that of other stations upon the west side of the valley, while at Orland it is considerably below that of the adjacent towns to the north. The annual precipitation is also subject to great variation from year to year, as indicated in the preceding table for Corning, Orland, and Willows.

This wide variation is, however, more apparent than real, as the heavy rains of the winter may at one season fall largely before January 1, and during a succeeding season not until after that date. Were the precipitation given for seasonal rather than for annual periods, or for the fiscal rather than the calendar year, the measurements would show a much greater uniformity.

The summer months are practically rainless, the greater part of the rainfall taking place during the period from November to March, inclusive. It usually occurs as gentle showers or as rains, continuing from one to three days, and is rarely accompanied by thunder and lightning or by violent or destructive winds. The occurrence of snow or hail in the valley is very rare.

The relative humidity is generally low, greatly reducing the sensible temperature during periods of excessive heat.

During the winter or rainy season periods of fair weather and cloudless skies alternate with the rains. Winter fogs common to the great interior valley of California are of occasional occurrence, but much less frequent than in the more southerly sections. During the summer clouds are rarely seen.

The prevailing direction of wind is from the north, and particularly during the spring and fall months the movement is often brisk. During the hot summer months heated dry winds from the north sometimes occur. These, in extreme form, are locally known as "northers," sometimes continuing for one to three days, and owing to

their heated character cause considerable damage to crops, particularly to nearly mature grapes and other fruits. The prevailing wind movement during the summer is from the south. The winds usually occur as gentle diurnal breezes, which moderate the heat of the valley. These are caused by the daily sea breezes which reach the interior by the way of the Straits of Karquines and are deflected northward up the valley. The south winds, like those of the north, are only occasionally dry and hot. During the rainy season brisk south winds usually precede periods of storm.

The climatic conditions are in general healthful and favorable to the growing and harvesting of crops, the summers being particularly suited to the production of hay and grains and to the ripening and curing of fruits.

AGRICULTURE.

The first authentic records of exploration are those of Gen. John Bidwell, who, in 1843, while in the service of General Sutter, of Sutter's Fort, on the site of the present city of Sacramento, traversed the entire valley. The following year several grants of large tracts of land, covering parts of the river bottoms and lower valley plains, were secured from the Mexican Government. During this year General Bidwell returned and located, southeast of the site now occupied by the town of Willows, a large grant known as "Larkin's Children's Rancho" for Thomas O. Larkin, of Monterey. Upon this grant the first dwelling was erected in 1846. In 1845 Bidwell secured for himself a grant of 2 square leagues of rich alluvial land at the site of the town of Colusa, on the Sacramento River, then occupied by a thriving village of native Indians of the Colusa tribe of Diggers.

Stock raising was the important agricultural industry of the early days of settlement, cattle of the long-horned Mexican type being introduced upon the Larkin grant as early as 1847, and sheep and hogs in the early fifties. After the discovery of gold, about 1849, hay and grain were grown in limited quantities to supply the demand at the mining camps. The development of agriculture at first was slow, being retarded by droughts, floods, grasshoppers, and the prevailing idea that the soil would not produce paying crops.

The first sowing of wheat was made upon the rich alluvial soils of the river bottoms, producing a yield of 40 to 50 bushels to the acre. With success in the raising of stock and the growing of hay, barley, and wheat, ranches multiplied and settlements sprang up in the vicinity of the Sacramento River and Stony Creek. The organization of Colusa County, embracing at that time also the territory now occupied by Glenn County, took place in 1851, with Monroeville as the county seat. The population of the county in 1853 is said to have been but little in excess of 100. At this time the county

seat was removed by act of the State legislature to the town of Colusa. Princeton, located on the Sacramento River, 14 miles north of Colusa, became a post-office in 1854 and an important river landing.

The ranches and rural settlements were gradually extended from the river bottoms to the valley plains. It was not, however, until the stimulation caused by the coming of the Northern Railway, now the Southern Pacific, that present valley points within the Colusa area assumed importance. The first business houses were erected at Orland and at Willows in 1875 and 1876. The town of Maxwell also came into existence about this time. Upon completion of the railroad, which reached Willows in 1878, a great part of the river settlements, business houses, dwellings, and population was transferred bodily to the railroad points and dry farming to grain in extensive tracts developed rapidly. The Colusa and Lake Railroad, affording connection between Colusa and the Northern Railway, was built by local capital and completed to Colusa Junction in 1886.

It is the invention of modern labor-saving machinery and the general use of the gang plow, throwing from 6 to 8 furrows and drawn by an 8 or 10 mule team, the wheeled broadcast seeder or grain drill, and the combined harvester hauled by 26 to 32 mules or horses, cutting, thrashing, screening, and sacking the grain at one operation, that has rendered this extensive system of agriculture—the general type of farming to the present day—possible or profitable. With improvement in the efficiency of machinery the capacity of operating over still larger tracts by use of the same equipment increased. The large holdings grew larger through the acquiring of small tracts operated by less successful farmers, who were often ruined by a single unfavorable season.

During the period of maximum production the quantity of wheat and barley produced in this section was enormous. Upon the holdings of the late Doctor Glenn, occupying some 46,000 acres near Jacinto, nearly 1,000,000 bushels of wheat is reported to have been grown in a single season. Large barges were and are still loaded with the sacked grain and floated down the river to San Francisco from this and adjacent river points in tow of stern-wheel steamers. In addition, large shipments are made by rail from warehouses established in various parts of the valley. More than 50,000 tons of grain have been shipped from some of these places in a single season.

The success attained in the production of grain under an extensive and inexpensive system of agriculture, without regard to the principles of rotation of crops, and with little attention to thorough culture or the application of farm manures or of other fertilizers, has not been without its injurious and depressing effects. In the handling of large tracts under such a system, the matter of preparing and

seeding the greatest possible area in the least possible time and at the least expense, rather than that of thorough cultivation and larger yields on more limited areas, has been the leading factor in success. Such methods, though perhaps necessary under certain economic conditions, ultimately lead to deterioration in the productiveness of the soil.

Summer fallowing was early adopted as a means of securing increased yields. Under this practice one-half the land lies idle during the growing season. Upon the most of the fallowed tracts, however, the land is merely plowed and rarely is any attempt made by subsequent cultivation to conserve the moisture for the following season. Notwithstanding the fallowing of the land every second year, the continued production of the one crop of wheat or barley has resulted in decreased yields. This has in turn given rise to failures, depreciation in land values, and to an increase in the number of mortgaged farms.

As the farmers of limited capital were forced to abandon the land, their small holdings were rented or absorbed by the owners of the more extensive tracts who could afford to operate for the narrow margin of profit allowed by decreasing yields and prices, and further concentration of the farming lands in great estates was effected, with corresponding decrease in population. According to the United States census for 1890 and 1900 this section of the Sacramento Valley, within the limits of that period, had decreased in population more than 12 per cent and the average size farm in Glenn and Colusa counties is given in the statistics for 1900 as 1,091.4 and 945 acres, respectively.

Many of the farm dwellings in these extensively dry-farmed districts are remote from neighbors, the post-office, public schools, or public highways, and are often of cheap construction. The farmsteads are frequently without shade or fruit trees, shrubbery, or the usual vegetable garden of eastern or irrigated districts. Instead of growing them, fresh fruits and vegetables are purchased from the Chinese vegetable vender, who makes regular trips through the country for many miles with the products of his small irrigated and intensively cultivated vegetable patch, which is located in the vicinity of the small towns or even at some distance outside the area. In the dry-farmed districts of the more productive and better drained soils, however, particularly west of Willows and Maxwell, and in the southwestern part of the area, substantial and attractive farm buildings prevail.

The methods employed, which involve the use of the highest types of farm machinery, are well adapted, in fact, are indispensable, to the present conditions imposed by this type of agriculture. The farm machinery is, however, expensive, and is often poorly protected, and the annual preventable loss through deterioration must be very

large. The operation of the machinery calls for the keeping of a large number of work horses or mules, which remain idle except during the plowing, seeding, and harvesting season. Heavy traction engines, as a substitute for horses, have come into use upon some of the larger ranches, crude oil being used as a fuel.

Plowing and seeding operations commence as soon as the rains of the fall have moistened the soils and may, under favorable conditions, continue until early spring. The fallow land is usually replowed, harrowed, and seeded about the time of or just before the early fall rains. While the plowing is frequently shallow and poorly executed and but little attention is paid to the conservation of soil moisture by subsequent cultivation, these operations are more thorough than in many parts of the Sacramento Valley. Owing to the necessity of allowing the standing grain to become dead ripe before cutting with the combined harvester, a considerable loss from shattering of the ripened heads occurs, which in favorable seasons sometimes produces a light second or volunteer crop the following year. Many of the fields are becoming badly infested with wild mustard and other rank-growing weeds, which is attributed to the long-continued use of the combined harvester, since screenings are by the use of this machine returned to the fields with the straw. In certain sections this condition is becoming so alarming that the combined harvester is being discarded for the smaller and less economical binder and stationary thrasher. There is considerable danger during the dry season of stubble and grain fields catching fire, and more or less loss from this source annually occurs.

The average yield of wheat per acre is at the present time probably not more than 15 bushels. The wheat is of somewhat inferior milling quality, owing to a relatively low gluten content. The Chile, Sonora, Australian, Salt Lake Club, and other club wheats have been the leading varieties. Barley is now grown more extensively than wheat, its output averaging four or five times that of wheat. A large part of it is cut green and cured as hay.

In this system of dry farming to grain the main cause of the decline in yield and the consequent injury to the industry has been the production of the same crop upon the same land year after year. The introduction in rotation of some forage crop, such as Canadian peas, alfalfa, the clovers, or some other legume which might be utilized as green manure, would prove of great benefit to the soil. However, owing to the long, dry, hot summer season the growing of most of these crops, under present conditions, is impracticable, and any general improvement must await the introduction of irrigation or the discovery of a legume or other soil-improving crop that can be grown without the aid of irrigation.

Irrigation has already been practiced in the vicinity of Colusa and Orland for several years, and its more recent introduction upon the river-bottom lands in the vicinity of Jacinto and Princeton, with the culture of alfalfa, fruits, vegetables, sugar beets, truck, and forage crops, has proved a success. While extensive irrigation of the valley plains has been discussed and irrigation works have been partially completed at great expense, progress in irrigation and intensive agriculture has been blocked by engineering difficulties, litigation, and the indifference and opposition of the landowners themselves, who here, as elsewhere in the interior valley, where grain can still be produced at a small profit, prefer in many cases to continue the direction of uncertain farming operations over an estate of one to many thousand acres rather than to take up the management of a smaller irrigated farm. In consequence this section of the Sacramento Valley, as stated in the publication already cited,^a while possessing greater natural advantages than some of the rich, intensively irrigated districts of southern California, has developed but a fraction of its productive capacity.

In the vicinity of Orland, Princeton, and Colusa, where there are several small orchards of young and thrifty bearing orange and prune trees, the growing of fruits has been carried on in a more or less experimental manner for some time. The fruit is of excellent quality, and on account of early maturity the oranges are ready for market in time to command fancy prices. Under careful methods of irrigation, tillage, and marketing the growing of citrus fruits in this section gives promise of success. While fall and winter frosts are of frequent occurrence, the fruit is seldom subject to damage or the trees to permanent injury, though the use of smudges or other forms of frost protection employed in most citrus-fruit centers might prove advantageous. Citrus fruits have also been planted in several outlying districts in the northern part of the area, but owing to lack of irrigation and thorough culture and to unfortunate location with regard to soil, this industry has here met with indifferent success. Upon the farm of Mr. P. D. Bane, located upon Stony Creek, about 1½ miles northeast of Orland, a thrifty and profit-producing almond orchard has been brought to maturity without the aid of irrigation. In this case, however, the most thorough and careful cultivation has been given the trees, while danger from late spring frosts is guarded against by the use of crude-oil smudge. Table and raisin grapes are also grown successfully in the vicinity of Orland and Maxwell without irrigation. Near the northeastern corner of the area and just east of the Sacramento

^a Water-Supply and Irrigation Papers, No. 86. Storage Reservoirs on Stony Creek, by Burt Cole, U. S. Geological Survey.

River prunes are produced, and in favorable sections of limited extent in the vicinity of Maxwell alfalfa is also grown to advantage without irrigation. In all these cases, however, alluvial soils which have marked power of retaining moisture and which are adapted to the several crops have been chosen.

In some cases moisture is supplied by capillary action or percolation from adjacent streams or from an underground source. It is likely that dry culture of almonds, grapes, figs, prunes, peaches, vegetables, and bramble or other small fruits and berries could be successfully extended to other favorably located sections in the vicinity of Stony Creek and the Sacramento River, and that a greater acreage could probably be used in the growing of grapes, fruits, and alfalfa upon the deeper and better drained alluvial soils bordering some of the minor foothill streams. This would, however, necessitate deep and thorough preparation of the land, followed, when devoted to fruits and to cultivated crops, by frequent and careful shallow cultivation during the dry summer season in order to conserve soil moisture. Even in these locations the growing of such crops will of course prove much more certain and profitable when irrigation facilities shall be provided. Any attempt to grow fruits or vegetables extensively upon the drier or less favorably situated valley lands without irrigation will probably result in failure, and should be discouraged.

Upon the rich river-bottom lands of the eastern section of the area, where irrigation has only recently been introduced, the growing of considerable quantities of tomatoes, melons, sweet corn, and other vegetables of excellent quality, suggests further possibilities along this line. In this and in the Orland irrigated district dairying is an important industry, supporting creameries at Orland, Jacinto, and Colusa. The production of alfalfa, sorghum, Egyptian corn, broom corn, and other forage or root crops is also of importance in connection with the dairying industry. Alfalfa gives four or five cuttings each season. Outside of the irrigated districts, however, dairying, other than to supply merely local demands, has been unprofitable. Hops are grown extensively in the northeastern part of the area east of the Sacramento River, and this industry might be considerably extended.

Sugar-beet culture, introduced during the last year, has aroused widespread interest and gives promise of becoming a permanent industry and aiding in the substitution of intensive agriculture under irrigation for the less profitable dry-land grain production. Although the crop of the first season, grown in the vicinity of Hamilton City, St. John, and Monroeville, has been somewhat light in tonnage, owing to delay in completing irrigation works and consequent lack of water at the critical period, the sugar content and percentage of purity

have been unusually high. The hand labor is performed mainly by Russian, Hindoo, and other immigrants, to whom allotments of land in small tracts are made upon a crop-percentage basis, or by Japanese labor under contract. In the coming year (1908), for beets grown upon other than the company's lands a price of \$4 a ton will be paid for 12 per cent beets, with 25 cents additional per ton for each additional 1 per cent of sugar. Seeding machines will be rented at the rate of 25 cents an acre and seed furnished at the rate of 15 cents a pound. The cost of production, including the cost of thinning, topping, and loading, which is done through the company by Japanese contract labor, is estimated at about \$25 an acre.

The raising of stock, consisting of sheep, goats, hogs, mules, and cattle, is an industry of much importance, although comparatively little attention is paid to the production of fancy or pure-bred stock. Wool and mohair are important commodities of export, the Twelfth Census reporting the production of Glenn County in 1900 as 328,020 pounds. During the summer season the sheep are generally driven to the mountains to graze.

Poultry and poultry products command good prices at all times, and opportunities are offered for those interested in this industry, which is now carried on only in a limited way, excepting the production of turkeys, which are raised for market quite extensively in some parts of the area.

While the introduction of intensive agriculture has in the past been discouraged, this opposition is gradually disappearing and there is a growing sentiment in favor of the subdivision and sale of the great land holdings and a change to irrigated crops. The large estates in the vicinity of the Sacramento River and covered by the Central Canal and its River Branch are now being sold in small tracts, and considerable immigration and development are taking place in this district. The better irrigable lands here generally sell for \$40 to \$100 an acre, while the dry-farmed valley tracts can be purchased for \$20 to \$60 an acre. In the irrigated districts the dwellings and farm buildings are generally neat and substantial and surrounded with shrubbery, shade trees, flowers, and lawns. The general appearance of thrift and prosperity is in pleasing contrast to that of much of the dry-farmed districts.

Owing to variety in soil and to favorable climatic conditions, the Colusa area is capable of the production of a wide range of fruits and field crops, and it is not likely that the extensive irrigation system already nearly completed will much longer lie idle or that progress in the construction of new systems will continue to be blocked by apathy or opposition.

While at present agriculture as a whole is unsatisfactory and in a state of unrest, indications point to an early development along agricultural and industrial lines, and, although this locality is less widely

known and much less attractive at present than many other extensively advertised sections of the State, it is believed to offer good opportunities for investment in irrigable farming lands by the industrious homeseeker of limited capital. Recently many thousands of acres have been subdivided for sale to settlers in the Sacramento River region.

SOILS.

The soil types of the Colusa area, twenty-two in number, fall into four more or less distinct broad natural divisions, based upon topography, origin, and mode of formation. There is, however, not only a gradual transition or gradation between the soil types, but the soils of these broad divisions themselves often pass gradually from one to another, owing to obliteration of the original boundaries by recent modifying agencies.

The greater proportion of the floor and slopes of the Sacramento Valley consists of clay, sand, and waterworn gravel of early Pleistocene time, derived by stream erosion from adjacent mountains and deposited during a time when the valley was submerged beneath the waters of a great inland lake or arm of the sea. A vast quantity of material was laid down, filling the valley to a great depth. Subsequently, uplift of the region and recession of the waters took place and the streams began cutting their channels, transporting the material to lower levels or to the sea. In this way much of the earlier deposits have been removed. The addition of later material by wash from adjacent slopes, the reworking and redeposition of the original material by the waters of intermittent streams, the removal of finer material by winds, and the weathering of the gravels and soil material have led to modifications in the character of the Pleistocene deposits, with corresponding differences in the soils.

In the extreme northern part of the area north of Stony Creek the Pleistocene material prevails and is least changed. South of Stony Creek it is modified to a greater extent and alternates with the more recent sedimentary formations, though covering a considerable proportion of the area nearly to Willows. In the vicinity of the foothills and in the extreme northwestern part of the area the early deposits have been greatly dissected by intermittent streams and the surface is rolling and hilly, but in the valley plain the surface is only gently sloping and the drainage is occasionally deficient.

This formation gives rise to three soil types, which have been correlated with the San Joaquin series, encountered and described in earlier surveys in the State. The soils of this series are prevailingly red in color, usually possess marked moisture-retaining properties, frequently contain excessive amounts of gravel, and are generally underlain by heavy subsoils and sheets of impervious, red, indurated material, or hardpan.

In the southern half of the area nearly all that remains of the earlier sediments has been covered with more recent stream deposits. The most extensive of these deposits have been derived by erosion from the foothills of the Coast Range and distributed by the floodwaters of intermittent streams entering the adjacent parts of the valley in this direction. With every heavy rain the streams traversing the foothill valleys become heavily laden with sediment washed from the surface of the bordering slopes. Upon entering the valley the streams overflow their banks, the water spreads, the velocity of the current is suddenly checked, and the coarser sediments, here generally consisting of fine sands and silts, are deposited, covering the original material of the valley slopes with a thin layer. In this manner some of these creeks have built up along their flood plains a slight ridge, the summits of which they traverse, until the slopes of the stream beds reach a minimum, when they break through the inclosing ridge, seek new channels, and build up other low, broad ridges. These streams finally enter the valley trough, where drainage is deficient and water frequently stands during the rainy season. The velocity of the current here is much slower and the finer silts and clays are deposited. As these processes are still taking place, considerable modification in the character of these materials, through erosion in one place and deposition of sediments in another, continues.

Recent sediments of this character cover the foothill valleys in the western part of the area, the minor drainage depressions in the northern and central portions, and, in the southern half of the area, form about three-fourths of the valley slopes and floor. The derived soil types, five in number, are classed and described as the Willows series. They are of a yellowish or reddish-brown color and are often of heavy texture and dense structure, although all but the heavier members are of a friable character when in proper condition as regards moisture. They are sometimes poorly drained and subject to the accumulation of alkali salts, but where favorably situated are among the most productive soils of the area.

In the vicinity of the Sacramento River and Stony Creek the processes of transportation and deposition of stream-borne sediments have been and are still active. These deposits are usually derived from a great variety of rocks and minerals, transported to the area from considerable distances, and constitute the third general topographic division of the soils. Each succeeding flood adds to the deposits or changes the character of surface or material. Stream channels have been filled with sands and gravels deposited from the more rapid currents, forcing the streams to cut new courses. The finer sands, the silts, and finally the clays are found assorted by the varying currents. Owing to the changes in the character and position of the streams the deposits are well stratified. Considerable modification of these sediments has also taken place through subsequent

erosion, distribution by winds, or through the addition of soil material by wash from adjacent soil bodies. This has resulted in much complexity in the soils and in their occurrence.

In that part of the area covered by these recent alluvial streams nine soil types occur, six of which are classified with the Sacramento series, two with the Orland series, and one, a nonagricultural type, as Riverwash. A few small soil bodies occurring in the vicinity of minor foothill creeks, while not typical, have enough similarity to soils of this formation (recent alluvium) to warrant including them in the above classification.

The soils of the Sacramento series occupy nearly level bottom lands of the eastern part of the area. They vary in color from a light gray to a dark drab, and are often deficient in drainage or subject to erosion and overflow from streams in flood. They merge gradually into the higher soils of the valley plain and are in themselves subject to considerable variation in texture and structure. The soils of this series are usually deep, friable, productive, and adapted to a wide range of fruit and field crops, and especially to those produced under irrigation and intensive cultivation.

The soils grouped under the Orland series consist of former or recent alluvial deposits from Stony Creek or minor streams, with an admixture of wash from adjacent more elevated soils. But relatively small areas of these soils occur, the most of which mark the course of former stream channels of Stony Creek. They are subject to considerable variation in color, texture, and structure, and merge gradually into adjacent soil types.

In the hilly western part of the area south of Stony Creek an entirely different set of topographic, geologic, and soil conditions prevail. The processes of rock weathering and decomposition have here given rise to residual soils or those formed by the decomposition of rocks in place. Unlike the soils of the previously described group, such soils are usually comparatively shallow, are not stratified, and grade gradually from the surface downward into the underlying parent rock.

The creep or slow natural movement of the soil down the slopes, aided by washing during the rainy season, has also covered the lower slopes and minor gulches and valley depressions with this weathered soil material of the upper slopes and summits of the hills, producing bodies of colluvial soils. One nonagricultural type, correlated with the Rough stony land of previously surveyed areas, and three types classified as the Sites series, constitute the soils of this division or group. The soils of the Sites series are of residual and colluvial origin, being derived by weathering in place of sandstones, shales, conglomerate, limestone, volcanic material, and more or less altered rocks of the lower foothills and through distribution of such materials

over the lower slopes by soil creep and wash. They are generally underlain, often at shallow depths, by sandstones or shaly sandstones or by heavy subsoils and strata of more or less indurated and cemented gravels, hardpans, or conglomerate, and merge by insensible gradation into the adjacent soil types. The soils of this series prevail along the western margin of the area.

The following table gives the names and extent of the various soil types of the Colusa area:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Percent.
Willows clay adobe.....	95,488	19.7	Orland fine sandy loam.....	7,168	1.5
San Joaquin loam.....	72,064	14.9	Norman clay adobe.....	6,208	1.3
Willows clay loam.....	60,480	12.5	Willows loam.....	5,568	1.2
Sacramento silty clay loam..	50,368	10.4	Rough stony land.....	3,392	.7
Willows clay.....	40,640	8.5	Riverwash.....	3,200	.7
Sites clay loam adobe.....	34,176	7.1	Sites loam.....	3,200	.7
Sacramento silty clay.....	26,368	5.4	San Joaquin fine sandy loam..	1,920	.4
Willows silty clay loam.....	24,896	5.1	Orland fine sand.....	1,856	.4
San Joaquin gravelly loam ..	13,376	2.7	Sacramento fine sandy loam..	1,472	.3
Sacramento gravelly sandy loam.....	11,840	2.4	Sites sandy loam.....	960	.2
Sacramento silt loam.....	9,728	2.0	Total.....	484,032	.....
Sacramento loam.....	9,664	1.9			

RIVERWASH.

Riverwash consists of a mixture of rounded or flattened gravel, cobblestones, sand, and finer sediments, the coarser material greatly predominating. It occupies the beds or portions of the flood plains of recent or present channels of Stony and other creeks and the Sacramento River, the main body extending in a northwest and southeast direction across the northern part of the area and following the course of Stony Creek. It merges into the adjacent fine sands and gravelly loams. It is derived from a great variety of rocks, and owing to its coarse, leachy character and likelihood of overflow is generally barren of vegetation and is of no agricultural value.

ROUGH STONY LAND.

The soil of the Rough stony land consists generally of a sandy loam of light-reddish color and of friable structure, similar in many respects to that of the Sites sandy loam. It occurs as elevated and rugged hill slopes and ridges, extending in a general north and south direction, and is prominent in that part of the area covering the foothills lying west of Maxwell and in the vicinity of Sites.

The soil, which is shallow, is of residual origin and greatly broken by outcropping massive ledges of sandstone rock and boulders. It supports a considerable growth of native grasses or brush. Owing

to the steep and rugged character of the slopes, the shallow soil, and the preponderance of rock outcrop, it is uncultivated, unirrigable and of little agricultural value save for grazing purposes, to which it is devoted.

SAN JOAQUIN GRAVELLY LOAM.

The San Joaquin gravelly loam consists of a yellowish-red to a deep-red loam, generally carrying an appreciable quantity of fine sandy material and a considerable proportion of fine to medium fine gravel. The latter consists of angular to rounded or flattened fragments derived from a variety of rocks, quartz often predominating. The interstitial soil material is generally of fine and often silty texture, and the soil becomes sticky and boggy when wet, is easily puddled, and upon drying assumes a compact, dense, adobe-like structure. It is underlain at 10 to 20 inches by a bright-red to deep-red, heavy, dense loam or clay loam of adobe structure, usually containing no gravel. At a depth of 2 to 4 feet this generally is underlain by an impervious indurated clay or sandy clay hardpan of red or yellow color.

This soil type occurs in the northwestern part of the survey as several moderately extensive bodies, frequently marked by small, irregular patches of dark-colored adobe soils, and occupying high rolling plains and slopes of the lower foothills. Numerous small patches of this soil also occur west of Willows along the ridges and slopes of the lower foothills marking the western margin of the area. San Joaquin gravelly loam merges gradually into the adjacent soils of the San Joaquin series. It is frequently dissected by small intermittent streams and marked by small bluffs, "hog wallow" mounds, or depressions a few yards in diameter.

The downward movement of water is arrested by the dense subsoil and hardpan, and while usually of quite pronounced slope, the soil is often poorly drained, retaining much water on the surface in depressions and within the soil throughout the rainy season. The subsoil has marked moisture-holding power, and in the deeper soil this should, with thorough and frequent cultivation, greatly increase the supply of moisture available for the crops.

The San Joaquin gravelly loam is probably an alluvial or lacustrine deposit derived from the Red Bluff formation, which was begun in the Pleistocene and finished in the Quaternary age. The underlying hardpan owes its formation to the physical and chemical action of iron compounds.

The San Joaquin gravelly loam is now devoted mainly to grazing or is dry-farmed to grain, the yields being nominal. Where the underlying hardpan does not come too near the surface, it should, under irrigation, drainage, and intelligent cultivation, prove well adapted to the growing of fruits and vines. Thorough prospecting for hardpan is, however, advised before engaging in such industries. Only in the

most favorable location and under the most intensive and watchful system of cultivation is the production of fruit likely to succeed without irrigation. Leveling for irrigation would generally prove expensive and should be so conducted as not needlessly to expose the underlying subsoil or hardpan. Water should be applied sparingly and supplemented by frequent cultivation, else the waterlogging of the soil in depressions and damage by seepage or run-off to lower lying lands may occur.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and the results of a single analysis of the subsoil of the San Joaquin gravelly loam:

Mechanical analyses of San Joaquin gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
14720, 16786.....	Soil.....	10.4	15.2	5.5	10.3	7.2	41.5	9.9
16787.....	Subsoil.....	5.0	10.8	5.0	10.4	1.6	53.4	13.7

SAN JOAQUIN FINE SANDY LOAM.

The soil of the San Joaquin fine sandy loam consists of a light-red fine sandy loam of somewhat compact structure, becoming rather sticky when wet and baking somewhat upon exposure. It is generally free from gravel, but carries a small quantity in washed or eroded places. It is generally underlain at 10 inches to 3 feet by a heavy red loam or clay loam subsoil, without gravel and of adobe structure, which soon grades into a red indurated clay or sandy clay hardpan.

This type of soil occurs as a few irregular bodies of small extent, occupying slightly undulating or gently sloping valley plains in the northern part of the area. A few small bodies lie midway between Jacinto and St. Johns.

In drainage features it is similar to the more elevated San Joaquin gravelly loam, and as in case of that type it is generally treeless and marked by slight unevenness of surface and by puddled depressions usually but a few yards in extent. It consists of Pleistocene and Quaternary sedimentary deposits, derived from the Red Bluff formation to the north, and is at present devoted to grazing or to growing grain under a system of dry farming. With irrigation the areas of deeper soil should prove well adapted to grapes and citrus and other fruits. As with the San Joaquin gravelly loam, the underlying hardpan is frequently too near the surface to allow the growing of deep-rooted crops, and a too copious use of irrigation water, even upon the deeper soil, would probably lead to an accumulation of water in local depressions and the waterlogging of the soil.

The following table gives the average results of mechanical analyses of the soil and the results of a single analysis of the subsoil of this type:

Mechanical analyses of San Joaquin fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
14719, 16790.....	Soil.....	1.9	8.8	8.3	22.2	13.7	34.4	10.8
16791.....	Subsoil.....	6.3	16.0	9.5	14.0	1.5	40.3	12.5

SAN JOAQUIN LOAM.

The San Joaquin loam varies considerably in texture and structure, but consists typically of a reddish or yellowish gray to light-red sticky loam, of fine and somewhat silty texture and somewhat compact structure. It has a tendency to puddle. It is often gravelly, the gravel consisting of small rounded fragments derived from a variety of rocks. It is underlain at 10 to 30 inches by a light-brown or reddish-brown heavy clay loam of compact adobe structure, extending to a depth of 6 feet or more, frequently grading at lower depths into a light-yellowish or red indurated clay hardpan or compact micaceous silt.

Throughout the northern and north-central parts of the area this soil occurs in extensive bodies covering gently sloping valley plains, usually treeless except in the vicinity of stream channels, and cut by intermittent minor stream courses. Small irregular areas are also found. The soil merges gradually into adjacent types. Puddled and poorly drained depressions frequently occur. The presence of hardpan is less prevalent and percolation and drainage less restricted than in the San Joaquin gravelly loam and the San Joaquin fine sandy loam. The subsoil aids in the retention of moisture, an important feature in a soil used for dry farming.

Like the other soils of the San Joaquin series, the San Joaquin loam is derived from early Pleistocene deposits more or less modified by subsequent erosion, weathering, and reworking. It is generally free from alkali and is superior to the San Joaquin gravelly loam and the San Joaquin fine sandy loam, but under present methods of continuous cropping to grain under a system of dry farming the yields are light. With irrigation it should be well adapted to alfalfa, fruits, and the general farm crops. Some of the depressions and lower lying areas of deficient slope would be greatly benefited by drainage, and the same caution as regards hardpan areas and the use of water in irrigation should be observed as with previously described soils of the San Joaquin series.

There is a light gravelly phase of this soil, which is light red in color and carries enough gravel to modify field conditions, while the compact subsoil and hardpan occur at a greater depth than in the soil as typically developed. The interstitial soil material is also of a coarser texture in the phase, approaching a sandy loam, and in some cases the soil becomes even light and porous, though such bodies are small in extent and grade insensibly into the adjacent heavier loams or into the gravelly soils of the Sacramento series.

The phase of soil just described generally occurs as slightly elevated ridges or as elongated bodies in the vicinity of intermittent streams or draws influenced by wash from adjacent higher slopes. The location and general extent of such areas is indicated in the map by the gravel symbol. It owes its origin to modification of the original material through removal of the finer soil particles or by the addition of coarser sandy and gravelly wash. It is often somewhat deficient in power to hold moisture and produces light yields of dry-farmed crops. Under irrigation it should prove a good soil for alfalfa, grapes, and tree fruits.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of San Joaquin loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
14715, 14717, 16792.	Soil.....	2.9	8.5	5.7	12.8	11.6	45.6	12.4
14716, 16793.....	Subsoil.....	.6	2.0	3.5	7.3	11.4	42.8	31.7

SACRAMENTO GRAVELLY SANDY LOAM.

The Sacramento gravelly sandy loam consists of a light sandy loam of pale-gray color, extending to a depth of 6 feet or more and carrying an excessive quantity of rounded or flattened cobbles and pebbles.

It occurs as treeless belts or streaks, often extending for long distances across the valley slopes and plains, and marking the course of former stream channels, or as small elongated and irregular bodies along the present stream courses. The larger areas occur in the vicinity of Stony Creek and Orland, extending in a northwest and southeast direction, while one area reaches from a point near Orland nearly to Willows, as a continuous body from one-fourth to one-half mile in width. It is often distinguished from the adjacent soil types by sharp boundaries, although it sometimes merges gradually into the adjacent gravelly soils.

The larger areas occurring upon the valley plains are frequently elevated slightly above surrounding soils. The smaller areas occurring in the vicinity of stream channels are in most cases subject to overflow during flood periods and many of them support a considerable growth of willows and small timber.

The Sacramento gravelly sandy loam consists of moderately recent material deposited along the courses of Stony Creek and the minor streams. It is unsuited to crop production, except with copious irrigation, and is consequently of little agricultural importance. It is dry farmed to grain, producing very light yields, or is devoted to grazing. The irrigation of this soil would call for the frequent application of large quantities of water and would endanger lower-lying land from seepage.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Sacramento gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16761.....	Soil.....	14.2	26.3	14.8	17.4	8.3	13.6	5.1
16762.....	Subsoil.....	16.6	29.6	11.4	19.2	7.7	9.1	6.0

SACRAMENTO LOAM.

The Sacramento loam consists typically of 6 feet or more of rather heavy sticky loam of dark-brown or dark-gray color. It contains varying quantities of gravel, consisting of rounded or partly rounded pebbles of many different kinds of rocks. Occasionally the soil is underlain by stream sands and gravels at a depth of 3 to 6 feet. While an appreciable amount of coarse, sharp, sandy material often occurs in the soil, it has a fine and often a rather silty texture and a somewhat compact structure.

The Sacramento loam occurs in moderately extensive or in long narrow areas in the sloping valley plains, or as small irregular bodies in stream bottoms and near minor foothill creeks. The larger areas occur in the vicinity of Orland, Stony Creek, and southwest of Orland. It is sometimes cut by small streaks or bodies of the adjacent soil types, into which it grades. Adjacent to streams it is occasionally subject to overflow, and here a considerable growth of brush and timber is often found. The higher areas are not subject to overflow and are well drained. The soil consists of recent stream deposits with an admixture of material derived by wash from higher lying soils.

While often carrying a large quantity of gravel, and somewhat porous and leachy, with copious irrigation it is well adapted to alfalfa and fruit. It is at present chiefly dry farmed to grain, although small areas under irrigation are devoted to citrus and other fruits and to alfalfa.

The following table gives average results of the mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Sacramento loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16771, 16773.....	Soil.....	1.8	4.6	4.1	10.6	14.4	48.4	15.3
16772, 16774.....	Subsoil.....	1.1	2.9	3.7	11.8	13.5	44.7	21.7

SACRAMENTO FINE SANDY LOAM.

The Sacramento fine sandy loam consists usually of 6 feet or more of grayish to light-brown micaceous sandy loam of medium fine to fine texture and porous structure. When wet it often assumes a greenish tint. It is occasionally streaked with layers of heavier sediments or underlain with river gravels and coarse sands at a depth of 3 to 6 feet. It sometimes occurs in small areas as wind-blown material, less than 6 feet in depth, in such cases being drifted over adjacent soil bodies.

This soil occupies a few small, irregular areas or narrow bands in the vicinity of present or recent channels of the Sacramento River. It merges into the adjacent Riverwash and the Sacramento silt loam. The surface is often uneven, being cut by sloughs or marked with numerous slight ridges, depressions, or dunes. It is often covered with rank growing weeds, vines, and willows and other trees of the river bottoms, and, although in itself well drained, it is frequently subject, when not protected by levees, to overflow and to erosion by floods.

The Sacramento fine sandy loam is of recent alluvial origin. Owing to texture, position, and uneven character of surface, it is generally devoted to grazing, but when leveled, irrigated, and improved by applications of stable manure, melons and other truck crops may be profitably grown. It is probable that larger areas of this soil could be utilized in this manner, though clearing the land of brush and leveling for irrigation is, even where practicable, sometimes quite costly. The practice of frequent irrigation and cultivation is important in the utilization of this soil type.

The following table gives results of the mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Sacramento fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16763.....	Soil.....	0.0	0.1	0.3	41.7	24.1	28.9	5.6
16764.....	Subsoil.....	.0	.1	.3	30.5	27.8	35.1	6.8

SACRAMENTO SILT LOAM.

The Sacramento silt loam is subject to much variation in texture and structure, is often broken by patches of related types of soil too small to be shown upon the map, and merges into surrounding soil types imperceptibly.

It consists usually of 6 feet or more of micaceous fine sandy to silty loam of moderately porous structure, but it is frequently streaked with strata of fine sand. Occasionally this soil is overlain by a heavy silty deposit several inches in depth. The color of the soil is generally light gray or brown, grading to drab in the lower lying and heavier areas, the deeper subsoil being lighter in color. The soil is sometimes underlain by sand and gravel at less than 6 feet.

This soil type occurs as small, narrow or irregular to extensive areas covering parts of the bottoms of the Sacramento River. A few small bodies also occur near Stony Creek. The surface is frequently cut by sloughs and remnants of former stream channels or is pitted and marked with numerous small depressions and ridges. It generally supports a heavy growth of oak or willow, sycamore, and other timber, with a tangled undergrowth of vines and shrubbery, forming the characteristic jungle of the Sacramento River bottoms. The lighter and higher lying areas some distance from the streams are well drained. Lower lying areas adjacent to the streams, when not protected by levees, are subject to overflow. Like the Sacramento fine sandy loam, the Sacramento silt loam is of recent alluvial origin.

While large areas of this soil type near the stream channels are utilized only as pasture or are waste land, in other sections the higher areas have been cleared of brush and timber and are used for dry-farmed grain or to a small extent for hops or for prunes and other fruits under intensive cultivation. The production of sugar beets under irrigation is also an industry of recent introduction upon this soil type. The expense of leveling, clearing, and protecting the land from overflow retards the development of this type of soil. Frequent cultivation and economy in the use of irrigating water are important matters to be considered. Overirrigation will be likely to result in

damage to lower lying soil bodies from waste and seepage waters. The soil is productive, easily drained and cultivated, and excellently adapted to the growing of irrigated crops, such as alfalfa, sugar beets, truck, and fruits.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Sacramento silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16765, 16767.....	Soil.....	0.0	0.2	0.1	8.1	15.5	64.8	11.4
16766, 16768.....	Subsoil.....	.0	.3	1.3	26.1	11.9	40.2	10.8

SACRAMENTO SILTY CLAY LOAM.

The Sacramento silty clay loam typically consists of dark-drab to dark-brown, micaceous silty clay loam of somewhat sticky and heavy character and generally 6 feet or more in depth. It is in most instances free from gravel or other coarse material. Though normally of a somewhat compact structure it rarely puddles, and is friable and easily tilled. Along the contact with the Sacramento silt loam it often is somewhat lighter or yellowish in color and is streaked with fine sand or fine sandy loam. In the vicinity of the valley plains it is occasionally underlain at less than 6 feet with the same red material that underlies the San Joaquin soils.

The Sacramento silty clay loam occurs as somewhat extensive and also as small, narrow, irregular areas, occupying nearly level flood plains, local draws, and lower hill slopes subject to wash or overflow from minor intermittent streams. The more extensive and typical areas occur in the northeastern corner of the survey where the soil extends across the river and in the vicinity of Hamilton City. Important areas are found near St. Johns, Jacinto, Glenn, and Colusa. The soil is marked by many sloughs. In the vicinity of streams there are found isolated trees or groves of valley oak, or a dense growth of small timber, sycamore, brush, vines, and rank growing weeds. The soil gradually merges into the soils of the lower valley plains and of the stream bottoms. It is generally well drained, although subject to occasional overflow from the larger streams when not protected by levees.

The Sacramento silty clay loam consists of fine sediments deposited in the flood plains of streams. It is devoted mainly to grain farming without irrigation, and near Hamilton City, St. Johns, and Monroeville to the production of sugar beets under irrigation. Alfalfa and other forage crops, hops, fruits, and truck crops are grown to some extent. In the vicinity of Colusa and Princeton the growing of prunes

upon this soil is attracting considerable attention and handsome yields are reported. Near Colusa citrus fruits are also grown to a limited extent.

The Sacramento silty clay loam is one of the most productive soils of the Colusa area and under irrigation is excellently adapted to the production of sugar beets, alfalfa, sorghum and other forage crops, vegetables, tree fruits, and small fruits. It is probable that hop growing could be extended to favorably located tracts without the aid of irrigation. Irrigation and intensive cultivation are, however, likely to be preferred upon this soil type.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Sacramento silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
14878, 16775, 16777.	Soil.....	Tr.	0.2	0.3	6.4	14.5	61.5	17.3
16776, 16778.....	Subsoil.....	0.0	.1	.3	3.1	1.6	73.1	21.1

SACRAMENTO SILTY CLAY.

The Sacramento silty clay consists of a black or dark-gray silty clay, usually without gravel, and of compact and often adobelike structure, puddling when wet, and baking and checking upon exposure during the protracted dry season. Under favorable moisture conditions and with proper cultivation, the higher and better drained bodies possess marked moisture-retaining properties and the soil breaks down into a friable loam similar in many respects to the Sacramento silty clay loam. The soil is generally 6 feet or more in depth, but is sometimes underlain at a less depth by lighter colored silty and sandy sediments or by heavy adobe clay materials.

The Sacramento silty clay occurs in the east-central and south-eastern parts of the area as irregular or elongated bodies extending in the direction of local drainage and occupying lower, nearly level, and generally treeless slopes and poorly drained depressions. It merges into the adjacent lighter loams and silt loam or into the heavier adobe of the lower valley plains.

This soil type consists of old stream flood-plain sediments mingled with wash from adjacent soils and from minor streams. The natural drainage is poor, and sometimes large quantities of alkali salts occur in the depressions. At present it is generally devoted to dry-farmed grain, giving low yields, or is used for grazing.

It is believed that, with deep and thorough plowing and early planting, followed by frequent cultivation, fair yields of field corn,

sorghum, broom or Egyptian corn, other forage crops, and vegetables could be produced without irrigation upon the higher areas where the soil is friable and free from alkali. With a moderate use of water, however, crop yields should greatly increase and the growing of alfalfa and sugar beets should become practicable. Irrigation should be supplemented by intensive cultivation and artificial drainage of the lower slopes and depressions.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Sacramento silty clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16781, 16783.....	Soil.....	0.5	0.9	0.7	4.7	3.8	55.2	33.6
16782, 16784.....	Subsoil.....	.1	.6	.7	3.5	4.1	54.3	36.5

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16781, 8.1 per cent; No. 16782, 3.1 per cent.

WILLOWS LOAM.

The Willows loam consists of a light reddish-gray or light-red friable loam of generally fine texture, though often carrying an appreciable quantity of sharp sandy material. It is of somewhat compact structure and is underlain at a depth of 10 to 18 inches by a reddish-brown or light-brown clay loam, carrying considerable sandy material but having a compact, dense, adobelike structure. In general appearance it is similar to the San Joaquin loam, but lacks the red hardpan found beneath the soils of the San Joaquin series. Frequently the proportion of the sandy material in the first few inches of the soil is sufficient to produce a light sandy loam.

This soil type, generally occupying rather small areas of irregular outline, is of frequent occurrence throughout the southwestern part of the area. It covers portions of the sloping valley plain near the foothills. The surface is sometimes slightly uneven or marked with "hog wallow" mounds, but in general the soil is well drained, free from alkali, and with a moderate amount of preparation well adapted to irrigation. The soil material is probably derived largely from the weathering of sandstone rocks of the foothills, and is similar in color and in general appearance to that of the Sites sandy loam. Unlike that type, however, it is of alluvial origin, being formed by the wash from hill slopes and by deposits from foothill streams.

It is usually devoted to dry farming to grain. Under irrigation it should be well adapted to alfalfa, vines, tree fruits, and small fruits. The areas lie usually above existing irrigation systems.

The following table gives results of the mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Willows loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16325.....	Soil.....	0.0	1.7	4.0	25.6	11.0	35.8	22.5
16326.....	Subsoil.....	.0	1.8	2.2	21.0	9.9	38.3	26.2

WILLOWS SILTY CLAY LOAM.

The Willows silty clay loam varies somewhat in texture, depth, and character of subsoil. It consists typically of a light ashen-gray sticky clay loam of a fine silty texture and compact structure, from 15 inches to 6 feet or more in depth. During the dry season the surface frequently becomes hard and checked. It is generally underlain by a heavy, compact, brown, yellowish-red, or reddish-brown clay loam of dense adobelike structure, which extends to a depth of 6 feet or more. It is generally free from gravel.

This soil type is of only moderate extent. It occurs as irregular bodies mainly in the eastern part of the area, where it occupies slight depressions or portions of the lower, nearly level, treeless plains. The drainage is generally somewhat deficient. The soil is alluvial in origin, being formed by the mixing of deposits of minor intermittent streams and wash from more elevated soil bodies, with the addition in places of material laid down by the river.

The Willows silty clay loam is devoted chiefly to grazing or to dry farming. Wheat and barley are the leading crops, of which fair yields are secured in favorable seasons. When well drained and free from alkali salts, with which it is sometimes impregnated, it should under irrigation be well adapted to alfalfa and sugar beets. The same care should be taken in the use of water as in the soils already described, otherwise much valuable land lying at lower levels will become damaged by seepage.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Willows silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
15352, 16797.....	Soil.....	Tr.	0.2	0.1	0.9	10.1	60.9	27.0
16798.....	Subsoil.....	1.4	1.7	.7	4.2	1.4	66.4	23.4

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16797, 3.3 per cent; No. 16798, 3.6 per cent.

WILLOWS CLAY LOAM.

The Willows clay loam is subject to considerable variation in depth, color, and structure, but consists typically of 3 to 6 feet or more of a heavy tenacious clay loam of light chocolate-brown color, becoming dry and hard during the dry season and checking somewhat upon exposure. In the immediate vicinity of foothill streams it is of somewhat lighter color and more friable structure. When less than 6 feet in depth it is generally underlain by a reddish-brown, heavy, compact clay loam, grading into a light-gray or yellowish compact clay.

This soil type is of wide distribution. It occurs as small and irregular to broad and moderately extensive areas. It often passes gradually into the Willows clay adobe or other adjacent soil types.

The Willows clay loam occupies draws or nearly flat depressions of the valley plain, but in the west-central and southwestern parts of the survey it occurs to a considerable extent in more elevated positions, where it covers higher valley plains near the foothills or the flood plains of foothill streams. In certain parts of these flood plains, which have been built somewhat above the surrounding country and extend as slight ridges toward the valley trough, the soil approaches in texture a silt loam, but such bodies are in point of extent of minor importance. The surface is generally smooth, except where cut by stream channels, and treeless, except in the vicinity of streams carrying water for at least the greater part of the year, where a thick growth of willows or other small timber may appear.

The Willows clay loam is derived from deposits laid down by the small foothill streams and by wash from slopes. It is generally free from alkali salts and is used for dry farming or for pasturage. The higher and better drained areas, where the soil is more friable, are particularly productive and are ranked among the most important lands of the area. In a few favorably situated localities alfalfa and grapes are successfully grown without the aid of irrigation. With irrigation, drainage, and careful cultivation this soil will be found well adapted to the production of alfalfa, sugar beets, and general farm crops. Most of it lies outside the area irrigable under the present canal system.

The following table gives the average results of the mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Willows clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
15351, 16801.....	Soil.....	0.0	0.6	0.8	7.8	8.7	53.5	28.5
16802.....	Subsoil.....	.0	.2	.6	9.8	5.7	67.2	17.0

WILLOWS CLAY ADOBE.

The Willows clay adobe, like the previously discussed types, varies to a considerable extent in depth, color, structure, and texture. Typically it consists of 6 feet or more of dark chocolate-brown clay, with a dense, compact adobe structure. It is usually free from gravel, except in the vicinity of foothills and foothill streams, becomes exceedingly sticky when wet, puddles readily, and during the dry season checks upon the surface. At lower depths the soil usually becomes lighter in color and sometimes lighter in texture than at the surface, although occasionally in small areas a heavy compact clay or clay loam similar to the subsoils of the San Joaquin series is found.

The Willows clay adobe occurs northeast of Orland and west of the Sacramento River as irregular or elongated areas, occupying local draws or depressions in the valley plain, or as much more uniform and extensive areas covering the valley plain throughout the southern half of the survey and extending from the foothills to the valley trough. It is generally treeless, except in the vicinity of stream channels. The lower lying bodies are often poorly drained and frequently carry large quantities of alkali salts. The more elevated slopes are generally well drained and free from alkali.

This soil type has probably been formed mainly from materials washed from foothill slopes or deposited by minor intermittent streams. It is particularly retentive of moisture and when well drained and in proper condition has a friable structure and is easily cultivated. It is devoted chiefly to dry farming. Alfalfa is occasionally grown without the aid of irrigation. The higher and more extensive bodies are productive and are classed among the more valuable lands of the area. Under irrigation they should be well adapted to sugar beets, alfalfa, and general farm crops. Much of the more valuable land of this type, however, lies above the present irrigation system.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Willows clay adobe.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
15350, 16807, 16810.	Soil.....	Tr.	0.4	0.5	4.2	10.5	45.9	38.4
16808, 16811.....	Subsoil.....	0	.3	.4	2.6	5.1	41.5	50.1

WILLOWS CLAY.

The Willows clay varies considerably in depth, color, texture, and structure, and is a rather indefinite type, merging imperceptibly into

the adjacent soil types. It consists typically of a reddish, yellowish, or yellowish-brown, compact, impervious, tenacious clay of adobelike structure, puddling when wet and baking and checking somewhat upon exposure to the sun. The immediate surface may sometimes carry an appreciable quantity of sandy material, probably of wind-blown origin, or may be covered to a depth of a few inches with a loam or sandy loam of red color. The soil generally extends to a depth of 6 feet or more, but at about 3 feet it is frequently marked by the occurrence of numerous calcareous concretions or by thin strata of calcareous clay hardpan.

The Willows clay occurs as extensive bodies occupying much of the nearly level, treeless valley plains, depressions, or troughs of deficient or arrested drainage lying to the south and southeast of Willows. During the winter or rainy season it is overflowed by the intermittent streams and by the drainage water from more elevated adjacent soil types. It is of alluvial origin, formed by deposits of foothill streams and wash from adjacent soil types. It generally contains alkali and is cultivated with difficulty, owing to the poor drainage and refractory nature of the soil. In its present condition it is best adapted to grazing, but with proper drainage, irrigation, and careful cultivation it may be reclaimed and become of value for the production of crops.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Willows clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16814.....	Soil.....	0.0	0.3	0.3	2.5	9.0	48.6	40.1
16815.....	Subsoil.....	.1	.4	.3	2.8	2.5	57.0	36.6

NORMAN CLAY ADOBE.

The Norman clay adobe consists of a dark-brown to black, heavy, tenacious clay adobe, puddling when wet, and baking and checking upon exposure, the cracks extending sometimes to the depth of 2 or 3 feet. It is cultivated with difficulty unless moisture conditions are favorable, when it assumes a moderately friable structure. In depth it is subject to considerable variation, but it usually extends from 3 to 6 feet. It is generally underlain by a more or less impervious and heavy clay or clay loam of yellowish or bluish mottled color, and occasionally by gravel beds or gravelly loams.

This inextensive soil type occurs in minor depressions of gently sloping or nearly level valley plains and in a few small, narrow valleys in the foothills. The larger bodies are found in the lower valley plain east of Willows. The areas are very irregular in outline and are

elongated in the direction of the flow of the minor streams. They are subject to overflow and are poorly drained.

The Norman clay adobe is of alluvial origin, being derived from the sediments laid down by intermittent streams or from materials washed from more elevated soils. Sometimes small amounts of alkali salts are present. With irrigation, drainage, and thorough cultivation it should produce alfalfa, grains, and general farm crops. At present it is used for grazing or for dry farming.

The following table gives the results of the mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Norman clay adobe.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16816.....	Soil.....	0.4	1.2	1.1	2.8	0.9	55.6	37.4
16817.....	Subsoil.....	.8	3.6	2.6	8.4	2.4	57.5	24.5

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16816, 6.4 per cent; No. 16817, 8.8 per cent.

ORLAND FINE SAND.

The Orland fine sand consists of 6 inches to 3 feet of dark-drab micaceous fine sand, sometimes approaching in texture a fine sandy loam. It is underlain by river sands and gravels extending to the depth of 6 or more feet. It varies greatly in character of soil material and in agricultural value, being marked by unevenness of surface and by the occurrence of small sandy or gravelly streaks, ridges, or mounds, or by small pits and bodies of heavier material. The depth of soil is also subject to great variation, the underlying gravel often outcropping at the surface. In general it is friable and open and of good tilth.

The Orland fine sand occurs as small, narrow bodies in the bottom lands along Stony Creek. It supports a moderately heavy growth of willows and bushes, small timber, or massive valley oak. It usually lies but little above the stream channels and is often subject to overflow and destructive erosion during floods. When protected from overflow it is naturally well drained, owing to openness of structure. The shallower and looser bodies do not retain moisture well, but where the underlying gravel does not too closely approach the surface the moisture conditions are better. This soil consists of recent stream deposits.

When protected from overflow the deeper areas are well adapted to alfalfa, vegetables, and in some cases to fruits. The land at present is devoted mainly to dry farming, grain and grain hay being the crops, or it is used as pasture.

ORLAND FINE SANDY LOAM.

The Orland fine sandy loam consists of a light grayish-drab or reddish-gray loam of fine sandy texture, generally free from gravel, and carrying considerable micaceous material. It is of friable and frequently of somewhat open structure, rarely puddling or baking. It varies considerably in depth, but is generally underlain at 15 to 40 inches by a compact grayish-brown heavy loam.

It occurs in a few elongated areas of a general northwestern and southeastern trend, occupying treeless valley slopes south and southeast of Orland and east of Willows. It often occurs as slight ridges or is marked by remnants of bluffs and terrace lines. It is naturally well drained, free from alkali, and easily tilled. It retains moisture well when properly cultivated and ranks as one of the most productive soils of the area. It consists of old alluvial deposits of Stony Creek or of minor intermittent streams, with an admixture of reworked Pleistocene sediments. It is devoted to dry farming, but owing to continued cropping in grain and to inefficient methods, the yield is comparatively light. Under irrigation it should be well adapted to alfalfa, citrus and other fruits, vines, vegetables, sugar beets, and general farm crops.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Orland fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16757, 16759.....	Soil.....	0.4	2.7	5.2	23.7	21.5	38.5	11.8
16758, 16760.....	Subsoil.....	.1	3.5	5.1	29.3	13.9	26.7	20.5

SITES SANDY LOAM.

The Sites sandy loam, which is subject to considerable variation in depth, color, and texture, consists of a friable sandy loam or medium sandy loam, generally without gravel and of light-reddish or reddish-gray color. The soil ranges in depth from a few inches to 3 feet or more and is underlain by partially weathered sandstone rock. Occasionally the color assumes a darker hue and the soil becomes of somewhat heavier texture and more compact structure.

This type of soil occurs in a few small areas occupying more or less elevated foothill ridges in the southwestern part of the survey. The surface is frequently broken by protruding irregular boulders or ledges of sandstone rock. The slopes are frequently so steep as to interfere with cultivation, and owing to position the areas are generally unirrigable.

The Sites sandy loam is of residual origin, being derived from sandstone in place. It is well drained and free from alkali, and used for dry farming to grain or for grazing. It is said to produce good yields during wet seasons, but owing to shallow depth and somewhat porous structure, it has little power to retain moisture in time of drought. Where favorably situated and not too much broken by rock outcrop this soil, if occasionally irrigated, should be well adapted to grapes, berries, or tree fruits.

The following table gives the results of a mechanical analysis of this soil:

Mechanical analysis of Sites sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16324.....	Soil.....	0.0	6.0	9.4	26.6	11.0	27.6	19.4

SITES LOAM.

The Sites loam consists of about 4 feet of a light-gray, compact, sticky, heavy clay loam, often checking upon the surface and resembling the adobes in structure. It is usually underlain by beds of light-colored argillaceous sandstones more or less mixed with limestone concretions, shales, or other material. It is frequently marked by the presence of gravel consisting of fine, light-colored, angular chips.

This is an unimportant soil, generally occurring as small, irregular patches on the summits and occasionally on the slopes of the lower treeless foothills northwest of Willows and west of Maxwell. It is probably of residual origin, frequently carries an excess of lime, is well drained, and free from alkali. It is often shallow and unproductive, and on account of position and character of surface is not adapted to irrigation. It is used as grazing land or for grain under dry farming, the yield usually being light, except in the most favorable seasons.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Sites loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16747.....	Soil.....	0.6	1.7	2.4	22.9	16.3	40.0	15.8
16748.....	Subsoil.....	.2	1.3	1.1	7.3	13.4	62.0	15.1

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16747, 2.2 per cent; No. 16748, 8.9 per cent.

SITES CLAY LOAM ADOBE.

The Sites clay loam adobe consists of about 3 feet of a reddish-brown or dark chocolate-brown to nearly black, heavy, sticky clay loam adobe, underlain by a heavy, compact red clay or clay loam adobe, or sometimes by red indurated clay hardpan or partially cemented gravel. The soil is, however, subject to considerable variation in depth, sometimes extending to 6 feet. It is generally gravelly, the gravel consisting of rather fine, partly rounded or angular fragments of a variety of rocks. Small areas in which the gravel content is excessive are indicated in the map by the gravel symbol.

The Sites clay loam adobe is the prevailing soil type of the lower undulating foothills forming the western margin of most of the area, and merges into the Willows clay adobe and other adjacent soil types without definite boundaries. It is frequently marked by numerous small bodies of the Sites loam, Sites sandy loam, and the San Joaquin gravelly loam, such areas being often too small to be indicated on the map. It is probably derived, through weathering, from the sandstones, shales, conglomerates, and other rocks forming these hills. It is generally unsuited for irrigation on account of the rough surface and is used for grazing and for the production of dry-farmed grain, the yield being fair in favorable seasons.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Sites clay loam adobe.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16752.....	Soil.....	0.4	1.9	2.7	8.9	9.9	47.1	28.4
16753.....	Subsoil.....	.7	2.7	2.8	8.6	12.4	42.6	30.0

The following samples contained more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 16752, 8.5 per cent; No. 16753, 20.4 per cent.

IRRIGATION AND DRAINAGE.

For twenty years or more relatively small tracts in the vicinity of Colusa and Orland have been irrigated by water taken from the Sacramento River and Stony Creek, and the extensive works of the Central Irrigation Canal system, for many years partly completed, have recently been placed in operation.

The extension of irrigation has, however, been slow owing to financial and engineering difficulties. Furthermore, economically to farm the large estates under irrigation, it was necessary that they should be subdivided by the owners or sold in small tracts to others. The holders of these large estates were unwilling to make so radical a change, and discouraged efforts to introduce irrigation on an extensive scale.

Present conditions are more encouraging. Partially completed canals and ditches, which for many years lay idle although capable of conducting water to thousands of acres in the vicinity of St. Johns, Willows, Princeton, and adjacent districts, are either being rapidly completed or are now supplying water to the lands and being extended farther south.

Smaller private enterprises are installing systems for the irrigation of small but productive tracts in the vicinities of Colusa and Hamilton City by pumping waters from the Sacramento River and from an underground source, and the U. S. Reclamation Service has begun construction work in the vicinity of Orland, upon the Orland unit of the Sacramento Valley reclamation project. This system contemplates the eventual conservation of the flood waters of the Sacramento River for the irrigation of a considerable part of the valley.

The drainage of the lower valley plains in the Colusa area, particularly in the southern half, is deficient. The periodical overflowing of portions of these low, flat districts is caused by the heavy rainfall received by the headwaters of the Sacramento and its tributaries; the slight grade of the lower stream courses which are often more or less choked by mining débris; and the present position of the channel of the Sacramento River which traverses a ridge built by the deposition of sediments and which is flanked upon either side by lower lying lands.

In this section many small lakes or ponds occur, which during the winter and spring receive the flood waters from creeks and sloughs, or the direct run-off from adjacent higher lying lands, but which during the summer appear as dry, shallow depressions barren of vegetation and checked with deep cracks.

The flooding of the depressions and the low-lying lands by the foothill streams, however, is not without benefit. Many of these streams when swollen are heavily laden with sediment, the deposition of which forms a productive soil and assists in building up the depressed areas. It is reported that efforts to direct the course of these overflow waters so that the deposition of sediments might take place where most needed have been successful in one or two instances in the vicinity of Maxwell. It is also a matter of common report, supported by observation, that by the deposition of sediments borne by these foothill streams considerable tracts, once containing alkali, have been added to the productive lands since the settlement of the region, and that the boundary of the poorly drained and alkali "wild goose lands" has been extended eastward.

Experience gained in other districts shows that where there has been a tendency toward lavish use of water the result has been to waterlog the soil and to collect excess seepage in local depressions, especially where the soil favored ready percolation. As the loose

gravelly soils in the northern part of the Colusa area permit of ready percolation, and as the rise of the water table and the collection of seepage waters in the lower lying lands of the eastern and southern parts of the area has been noticed, care should be taken to avoid excessive irrigation.

ALKALI.

In the Colusa area, especially throughout a large portion of its southern half, alkali salts are of general occurrence. In the southern portion of the area about one-third of the land carries alkali salts in sufficient quantities to become more or less a menace to irrigated crops, and much of the lower and poorly drained "wild goose lands" is now incapable of producing any crop, being used for grazing only.

All the common alkali salts, viz, sodium chloride, or ordinary salt, sodium sulphate, or Glauber's salt, and smaller quantities of sodium carbonate, or sal soda, occur in this part of the Sacramento Valley. The greater part of these soluble salts probably originates in the alkali-bearing shales and other sedimentary rocks of the Coast Range. The general distribution of such soluble salts throughout the deeper subsoils is indicated by their presence in relatively large proportions in the well water of certain parts of the area, particularly in the vicinity of Maxwell and in some of the outlying districts. The concentration of the alkali salts in the lower valley plain or depressions of deficient drainage has been caused mainly by evaporation from flood waters charged with small quantities of alkali salts, leached from the higher adjacent soil bodies and from the alkali-bearing rocks of the Coast Range.

The alkali conditions of the Colusa area exhibit a number of somewhat unusual features, which are frequently very misleading to the observer. The native grasses and herbaceous plants usually depended upon for assistance in indicating the presence and, roughly, the quantity of alkali salts in the soil were frequently found to be utterly unreliable. In parts of the lower Colusa Basin the surface indications point toward a high alkali content, yet only a relatively small quantity may be present, usually occurring in or near the immediate surface. To the west of this district and upon the somewhat higher lands field tests have frequently established the presence of much larger quantities of alkali salts, often amounting to an average of one-half to more than 1 per cent in the 6 feet of soil, although much of this land is cultivated and producing fair crops of grain. The maximum concentration is in such cases, however, generally found at a depth of about 3 feet, the surface foot, within which the shallow-rooted crop feeds, being comparatively free from alkali salts. In general, the maximum concentration is encountered at about this depth in those districts in which the average total salt content is not in excess of 0.60 per cent. Where the total salt content exceeds

this figure, the maximum concentration may occur in almost any foot of the soil section, or the salt content may prove nearly uniform to a considerable depth.

The northern half of the Colusa area is practically free from harmful concentrations of alkali, therefore the map accompanying this report shows the various alkali areas as they occur in the southern part. The map itself covers a little more than one-half of the whole area surveyed, or 253,568 acres.

The following table gives the actual and relative extent of alkali according to its degree of concentration:

Area of different grades of alkali land.

Amount of alkali.	Acres.	Per cent.
0 to 0.20 per cent.....	141,504	55.8
0.20 to 0.40 per cent.....	32,384	12.8
0.40 to 0.60 per cent.....	34,368	13.6
0.60 to 1 per cent.....	30,720	12.1
1 to 3 per cent.....	14,592	5.7
Total.....	253,568	.....

The extent and position of the alkali areas will be seen in the alkali map accompanying this report. The classification of the land is based upon the average salt content to the depth of 6 feet, as determined by field analysis, and the different grades are distinguished by color and symbol. Where the average alkali content is less than 0.20 per cent no injury to crops may be feared under present conditions. Many crops can be successfully grown where the average concentration falls within the second limit, from 0.20 to 0.40 per cent. Most grain crops will, however, suffer more or less under a uniform distribution of this quantity of alkali salts through the soil section, although, of course, as previously explained, grain and other shallow-rooted crops may be grown under a much greater average salt content if the part of the soil section entered by the shallow root system be comparatively free from these substances. While under such conditions grain is grown over considerable bodies of land in the Colusa area in which the average alkali content exceeds 0.60 per cent, this quantity would, under a uniform distribution, prove too great for any ordinary crop. Even here such lands are more often devoted only to grazing. An accumulation of 1 per cent of alkali salts in soils is, when considered in terms of pounds to the acre, a very large quantity, and production of crops on such soils can take place only under the most unusual and favorable conditions. In one body of moderate extent occurring about 4 miles east of Norman, although the average alkali content to the depth of 6 feet is less than 0.20 per cent, there is a heavy

concentration in the immediate surface, and the growing of shallow-rooted crops would be precluded under such conditions even were the land otherwise adapted to cultivation. This surface concentration is indicated by a system of hatching, otherwise the map would in this instance be entirely misleading.

The alkali soils of the Colusa area may be roughly grouped as occurring in three more or less distinct topographic districts, viz, in the small foothill valleys and the adjacent portion of the main valley floor, in the lower valley plain, and in the river district. In the first-mentioned district the areas in which the average alkali content is sufficiently great to be indicated upon the map are usually small, although affected spots are of frequent occurrence in the stream valleys or draws of the foothills along the entire western margin of the area south of Wilson Creek. The maximum concentration rarely exceeds 0.60 per cent. The highly injurious black alkali is found here, but it is not of general occurrence.

By far the larger bodies of alkali soil occur upon the "wild goose lands" of the lower, poorly drained section of the valley plain, extending south and southeast of Willows as irregular and generally more or less continuous bodies across the entire southern half of the area. Large areas carrying high concentrations occur east of Norman and southwest and northeast of Colusa Junction, where wide tracts of unproductive or barren land are found. Probably the most extensive unbroken bodies of such land lie along the line of the Southern Pacific Railway, extending from near Delavan to Willows, and along the wagon road connecting Norman and Princeton. The alkali salts of this district consist largely of sodium sulphate, with a smaller amount of sodium chloride and probably other chlorides. The extremely injurious sodium carbonate, or black alkali, is usually wanting.

In the vicinity of the Sacramento River there are but few areas where the total salt content is sufficient to warrant mapping, and in these the maximum concentration generally occurs in the surface foot. One body of considerable extent is found near the extreme southeastern corner of the survey. Nevertheless, in this section and in proximity to some of the most productive and highly developed districts of the area black alkali is common. This generally manifests itself as numerous small barren spots dotting the surface of the fields. Such spots are usually only a few yards or rods in diameter, but owing to their number and to the corroding character of the alkali present, not only is the general attractiveness and thrifty appearance of the country marred, but in the aggregate a considerable area of land is rendered unproductive. While the separate spots are in general too small to be shown upon the map, the districts in which their occurrence is common are indicated by hatching.

While the production of dry-farmed crops has been unusually successful upon some of the alkali lands of the area, the further concentration of the salts is certain to result with increased irrigation, and this constitutes a serious problem in the cultivation of the lower lying lands. The danger may be avoided only by preventing the accumulation of water in the soil or by its removal through drainage. The suggestions made in regard to drainage and the moderate use of water in irrigation in the discussion of the prevention of swamping and waterlogging the soils apply equally well to protection of the land from the rise of alkali and need not be reiterated here.

The efficiency of flooding, coupled with the establishment of underground tile drainage, in the reclamation of alkali lands in the San Joaquin Valley and elsewhere has been thoroughly demonstrated by past experiments. Owing, however, to the present low value of lands in this area and to the extremely dense and impervious character of the soils of the valley floor, and also to the necessity of providing drainage with adequate outlets for so extensive an area, the installation of expensive systems of tile drainage can hardly be recommended to the ordinary farmer. With future development of the country and the consequent increase in land values, the reclamation of portions or all of this area may prove feasible, although expensive and difficult. Such projects are, however, to be reserved for the capitalist and the drainage expert.

The average homeseeker or investor in farming lands would better confine his investments to the higher, well-drained sections of the valley plain and river bottoms. He should purchase only after due consideration and inspection, and should bear in mind that the well-drained, irrigable, and really desirable lands in the southern half of the area are confined to a comparatively narrow strip near the Sacramento River. Although large bodies of excellent farming land occur throughout the western part of the survey, these can not at present be irrigated, and, with the exception of a few favorably situated districts, are suited only to dry farming or the raising of stock.

HARDPAN.

Hardpan may be defined as more or less impervious material occurring in the soil or subsoil, usually as strata or sheets from a fraction of an inch to several feet in thickness. Such material may consist of more or less well-defined strata of foreign matter, such as volcanic mud, or may be due to a compact condition of the soil or subsoil. It is usually caused, however, by induration or partial cementing of the soil grains by common salts deposited from soil solutions or percolating waters. The most common of such cementing substances are lime, alkali salts, and iron compounds.

An impervious sheet in the soil or subsoil arrests the percolation of rain waters, causing the surface soil in times of heavy rains to become boggy and poorly drained; prevents the development and penetration of roots in the soil, thus limiting the feeding ground of the crop to the soil lying above the hardpan; hampers cultivation if the hardpan occurs within the depth reached by ordinary farming implements of tillage, and checks the capillary movement of moisture toward the surface, rendering the soil particularly sensitive to drought.

In the Colusa area the occurrence of thin strata of soil material more or less cemented by lime and alkali salts is common in some of the soils of the Willows series, and is treated under the heads of the individual soil types. The prevailing form of hardpan, and the one which has the most marked influence upon agricultural interests, however, is associated with the soils of the San Joaquin series, and owes its formation mainly to the deposition of iron compounds from percolating soil solutions and the cementing action of such salts upon the soil grains.

The soils of the San Joaquin series usually possess marked moisture-retaining power, but when the underlying hardpan is found near the surface, or a short distance below, the soils are often sticky and boggy when wet and are cultivated with difficulty. During the dry summer season the moisture quickly disappears and the crop suffers from drought. In such cases the penetration of the roots of alfalfa, vines, or other deep-rooted plants is effectually prevented, the plants frequently growing vigorously until the impenetrable hardpan layer is reached, when they become stunted or die.

Although in the Colusa area hardpan does not always occur within the root zone of crops in the San Joaquin series, yet the failure of water to percolate into the subsoils and its collection in pools in the depressions during the rainy season may reasonably excite suspicion of the presence of hardpan. In such cases an examination of the soil for hardpan, by the use of an auger or probe, is advised before planting trees, vines, or other deep-rooted crops. Where the impenetrable material does not approach the surface more closely than 3 feet the vines will frequently do well, but the planting of citrus or other trees is attended with risk. In such cases shattering the underlying hardpan by the use of blasting powder or dynamite is sometimes resorted to with good results. Hilgard^a recommends for this purpose the use of one-half to three-fourths pound of No. 2 dynamite at a depth of 3 to 5 feet, and further suggests that an additional charge of "from 1½ to 2½ pounds of black powder placed above the dynamite will throw out sufficient earth to plant the tree without further digging." This process is laborious and somewhat expensive, and is applicable only to intensively cultivated sections.

^a See "Soils," by E. W. Hilgard, p. 181.

SUMMARY.

The Colusa area embraces about 756 square miles, lying west of the Sacramento River and in the north-central part of the Sacramento Valley. This valley covers an area of more than 2,500,000 acres, forming the northern part of the great interior valley of California, and consisting of nearly level and generally poorly drained swamp and overflow land and partially developed farming districts, nearly inclosed by high mountains and drained by the Sacramento River and its tributaries.

The area surveyed consists of a narrow strip of lower undulating foothills lying along the western margin of the valley; a great scope of gently sloping, treeless valley plains, covering the main portion of the area; and, in the eastern portion, a considerable extent of productive and attractive bottom lands of the Sacramento River.

The area, although somewhat sparsely settled, is undergoing a period of development. Transportation is afforded by two lines of railway, with various branches, and by Sacramento River steamboats. The climate is characterized by an annual mean temperature of 60° to 65°, an average annual rainfall of 15 to 20 inches, nearly all of which occurs during the winter months, and by mild winters with frequent light frosts and summers of low relative humidity, high temperatures, and cloudless skies. The wind is frequently brisk and sometimes hot and dry. There is a general absence of snow, violent storms, thunderstorms, or hail. The climatic conditions are in general healthful and favorable to the production of ordinary temperate and some subtropical crops.

An extensive system of dry-farming of grain has been the general type of agriculture. This has resulted in a sparse population, decrease in productivity of lands, failure upon the part of the owners of the smaller tracts and concentration of the land in large holdings, and in indifference or opposition to the development of irrigation and intensive agriculture.

Large areas of land are well adapted to irrigation, and where practiced with the production of fruits or field crops it has proven successful. An awakening to the possibilities of irrigation is now taking place, as shown by the construction and extension of irrigation systems, the gradual breaking up of the great estates into small tracts under irrigation, and the development of the sugar beet, alfalfa, dairying, and fruit-growing industries.

With the exception of the two nonagricultural types, the soils are classified under five series. The San Joaquin series occurs in the more elevated and better drained parts of the valley floor, and the soils are usually of a reddish color, often gravelly and generally underlain by heavy, impervious, dark-red clayey subsoils or indu-

rated clay hardpan. Of this series the San Joaquin loam is the most extensive and productive, covering large sections in the northern and north-central parts of the area. It is devoted to dry-farm grain growing. Owing to the common occurrence of hardpan, the soils of this series are often not adapted to deep-rooted or ordinary irrigated crops.

The Sacramento series consists of deposits of the Sacramento River and its tributaries, covering bottoms or lower valley slopes. The soils of this series vary in texture from loose gravels to fine river silts and clay loams or clays, and in color from light gray to nearly black. The Sacramento silty clay loam is the most extensive and important type of this series. It is especially well adapted to sugar beets, hops, alfalfa, prunes and other fruits, and vegetables.

The Willows series covers a wide extent of country, ranging from the upper valley plain at the base of the foothills to the lower sinks of the valley floor. The soils of this series are the products of washings from higher soils and of sedimentation from foothill streams and vary greatly in agricultural value. They range in color from reddish to dark brown or nearly black. The clay loam, the clay adobe, and the clay are the most extensive soils of this series. The former is nearly always productive, the second productive when well drained and free from alkali, and the last mentioned generally poorly drained and carrying large quantities of alkali salts.

The Orland series consists of old or recent stream sediments with an admixture of washings from adjacent soil types. The Orland fine sandy loam is the most extensive of this series. It is an important soil type and well adapted to irrigated crops.

The Sites series consists of colluvial and residual soils occurring in the foothills. Owing to position and to irregular character of the surface they are not adapted to irrigated crops. The Sites clay loam adobe is the most extensive.

Development in extensive irrigation has been retarded by the system of dry farming in vogue, the necessary cost of extensive and adequate headworks and canals, and by the opposition of navigation interests to the use of the waters of the Sacramento River.

The total amount of land irrigated consists of a few relatively small areas in the vicinity of Colusa, Princeton, Hamilton City, and Orland, in all but a few thousand acres, but the irrigated area is now being extended in the vicinity of Willows, Colusa, and Princeton, by the completion of a comprehensive system of canals and ditches, utilizing the water of the Sacramento River, and by the installation of many smaller pumping plants.

The establishing of an irrigation project upon Stony Creek by the U. S. Reclamation Service for irrigation of a considerable body of

land in the vicinity of Orland is under consideration, and the irrigation of other large areas seems possible by storing flood waters in mountain reservoirs.

All the common alkali salts occur to a greater or less extent in the Colusa area. The high concentrations are limited to the southern part, mainly in the poorly drained "wild goose lands," where accumulation is almost solely the result of natural causes—that is, not due to irrigation. Grain is successfully produced over large areas in which the accumulation of alkali salts is excessive, the surface foot, however, being comparatively free from alkali.

In the vicinity of the Sacramento River bottoms barren alkali spots, sometimes caused by an accumulation of the extremely injurious "black" alkali, are of frequent occurrence.

Thorough underground drainage, coupled with frequent flooding, is the most effective way to reclaim alkali lands. While this method is not at present feasible in the extensive alkali areas of the valley plains, the smaller alkali spots of the river bottoms could be economically reclaimed in this way.

There are opportunities for profitable investment in farming land in the Colusa area, but purchase of the poorly drained or alkali lands should be made only after thorough study of the conditions and of the opportunity for and the probable expense of reclamation.

SOIL SURVEY OF THE REDDING AREA, CALIFORNIA.

By MACY H. LAPHAM and L. C. HOLMES.

DESCRIPTION OF THE AREA.

The Redding area covers about 200 square miles, embracing the principal agricultural district of Shasta County, Cal. It is irregular in outline and extends north from Cottonwood Creek, which here forms the southern boundary of Shasta County, a distance of some 20 miles. From east to west its greatest breadth is slightly less than 16 miles.

It occupies the upper or northern part of the great depression known as the Sacramento Valley. This depression, constituting the most important agricultural region of the northern half of the State, is about 4,000 square miles in extent. It is inclosed by the Sierra Nevada and the Lassen Peak Ridge of the Cascade Mountains upon the east, the Coast Range upon the west, and the Klamath Mountains, formed by the coalescing of these ranges, upon the north.

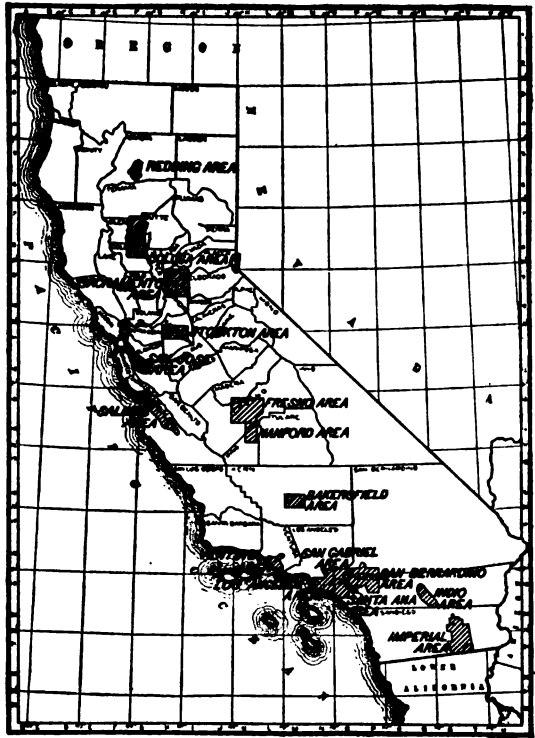


FIG. 33.—Sketch map showing location of the Redding area, California.

The extreme northern part of this depression is cut off from the main valley of the Sacramento River by a low, wooded ridge extending outward from the foothills upon each side of the valley, through which a short distance north of the town of Red Bluff the Sacramento passes by a narrow gorge known as Iron Canyon. The valley proper

has been eroded by the Sacramento River from the stream deposits of clays, sands, and gravels laid down at an earlier period in this depression. The valley within the area surveyed is from a half mile to 3 miles in width. In the vicinity of the town of Anderson it attains its maximum width and greatest agricultural importance, and it is here known as the Anderson Valley. The Sacramento River, which traverses the area in a southeasterly direction and flows through a wide and generally shallow channel, often marked by riffles formed by gravel bars, is frequently bordered by sand bars and wooded bottoms, or by bluffs sometimes rising to nearly 100 feet in height. The valley bottoms support a vigorous growth of valley oak or a dense covering of cottonwood and sycamore, with an almost impenetrable undergrowth of "willows," brush, and vines. The adjacent valley slopes are usually dotted with groves or individual oaks and support during the winter and early summer a good growth of nutritious grasses.

West and southwest of the Sacramento River and its recent valley the survey embraces a comparatively large tract of rolling or sloping plateaulike country, often greatly dissected by streams, and made up of earlier stream deposits from 100 to 200 feet or more above the recent valley floor, from which it is generally separated by well-marked bluffs or terraces. This rolling or elevated plateaulike country extends beyond the western boundary of the area and merges in the foothills of the Klamath Mountains. Its numerous minor stream valleys are generally more or less forested with live and deciduous oaks and digger pines, and are often covered with a dense growth of chaparral consisting of manzanita, coffee berry, and ceanothus. East from Anderson, where this region becomes important agriculturally, it is known as Happy Valley. The main tributary streams of the Sacramento in this section of the area are Cottonwood and Clear creeks, which traverse narrow valleys and maintain a small flow of water throughout the dry season. The Clear Creek bottoms, as is the case in other parts of the area, have been more or less disturbed by hydraulic mining operations and the stream courses partially filled or obstructed by débris.

The northern half of that portion of the area lying east of the Sacramento River is similar in character to the Happy Valley section, but is rougher, more deeply dissected by stream courses, and has somewhat shallower soils. It is bounded upon the north and west by a region of shallow, rocky, residual soils of the mining district of the Klamath Mountains and adjacent foothills. In the southern half of this section these wooded rolling hills gradually give way to gently sloping treeless plains known locally as the Stillwater Plains. Here is found a shallow, gravelly soil, which, in the vicinity of the narrow stream valleys or minor stream courses, supports some timber.

The northern and eastern parts of the area are drained principally by Churn, Stillwater, and Cow creeks, which flow south. It is principally in the narrow valleys of these streams that the farming lands of this district are located.

By far the greater part of the agricultural population is confined to the Anderson and Happy valleys, where in places the country is quite thickly settled. In other parts of these districts, where the farms are larger and farm dwellings some distance apart or where the land is uncleared of timber and brush and used only for grazing, the population is rather sparse. In the rougher and more hilly districts and upon the treeless plains of the southeastern part of the area the population is confined to a few small clearings or cultivated farms upon the uplands and in the minor stream valleys. The farming class is of a cosmopolitan character, drawn not only from the various parts of the United States but from foreign countries.

Redding, the county seat of Shasta County, now has a population of about 5,000, and is the principal town. It is a shipping center and outfitting point for near-by mining camps, which have contributed greatly to its development. Anderson, having a population of about 1,000, is the main fruit-shipping point and agricultural center. Cottonwood, a smaller town near the southern boundary, is the center of a small fruit district. Bellavista, a little town near the northeast boundary, is the site of a lumber mill and box factory of considerable size.

Transportation is furnished principally by the Portland and San Francisco branch of the Southern Pacific Railway. The Anderson and Bellavista Railway, connecting Anderson with Bellavista, is used mainly for lumber and ore shipments.

The Redding area is well provided with public roads, which in the more thickly settled districts are of excellent character.

Fruits and other farm products are shipped to the East, to San Francisco and vicinity, and to Portland and other cities to the north. The towns and mining camps of northern California and Oregon also afford excellent markets for fruits, vegetables, hay, poultry, and dairy products.

CLIMATE.

The climate of the Redding area is characterized by a long, warm, dry summer season, followed by a mild, rainy winter season.

The normal annual precipitation at Redding, at an elevation of 552 feet, is reported by the United States Weather Bureau as 36.11 inches. This is somewhat in excess of the rainfall reported for the more southern Sacramento Valley points, the precipitation, for instance, at Red Bluff—elevation, 309 feet—at the head of the main valley, being 26.11 inches. Owing to slightly greater elevation and proximity to the mountains it is probable that at Redding it is somewhat greater than

at Anderson and over the principal agricultural section of the area, but no data covering the latter district could be obtained. At Shasta, outside the limits of the survey, 5 miles northwest of Redding, in the foot hills, at an elevation of 1,148 feet, the precipitation is 49.90 inches.

During the summer local showers, sometimes accompanied by thunder and lightning or hail, are of occasional occurrence. Very little rain falls from May to October. During the winter showers and rain spells, sometimes continuing for two or three days, alternate with periods of fair weather. The rains are usually gentle, but the pronounced slopes carry off much that might be absorbed by the soil. During the long dry period the native grasses dry up and the country appears somewhat barren. Much of this naturally cured grass, however, is quite nutritious. The first fall rains start a new and abundant growth of pasture grasses. In the more elevated parts of the valley snow sometimes falls, but this is rare, and it never remains on the ground for any length of time.

The normal monthly and annual temperature and precipitation, as published in the official records of the United States Weather Bureau for stations at Redding and Red Bluff, are given in the following table:

Normal monthly and annual temperature and precipitation.

Month.	Redding.		Red Bluff.		Month.	Redding.		Red Bluff.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	° F.	In.	° F.	In.		° F.	In.	° F.	In.
January	45.2	7.29	44.9	4.67	August.....	81.0	.09	81.1	.02
February	49.3	4.22	49.0	3.70	September ..	74.0	.67	73.8	.67
March.....	53.8	4.75	54.5	3.27	October.....	64.5	2.48	63.5	1.26
April.....	60.2	3.01	59.3	2.16	November ..	54.1	3.79	53.9	3.10
May.....	67.2	2.19	67.0	1.33	December...	47.0	6.74	46.7	5.31
June.....	75.6	.79	74.4	.49					
July.....	82.3	.00	81.8	.03	Year..	62.9	36.11	62.5	26.11

The normal annual temperature, as will be observed from the above table at Redding, is 62.9° and at Red Bluff 62.5° F. At Sacramento, upon the south and 160 miles distant from Redding in an air line, it is 60° or 2.5° less than at Red Bluff. July is usually the hottest month, the thermometer during the summer frequently having a daily maximum of more than 100° F. At Red Bluff the highest recorded temperature is 114° F. While the summer temperature is sometimes extreme the nights are usually cool and pleasant, the relative humidity low, and hot winds less frequent than to the south in the main valley.

The minimum temperature recorded at Red Bluff is 18° F. The frosts, which are of frequent occurrence during the winter, are, however, usually not severe, and hardy vegetables remain in the ground uninjured during the winter. The dates of first and last killing frosts at Redding and Red Bluff as reported by the Weather Bureau follow:

Dates of first and last killing frosts.

Year.	Redding.		Red Bluff.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1897.....			Mar. 30	Dec. 20
1898.....	Mar. 27		Mar. 18	Dec. 9
1899.....	May 1	Dec. 14	Feb. 7	Dec. 19
1900.....	Feb. 9	Dec. 3		Dec. 30
1902.....	Mar. 14	Nov. 20		
1903.....		Dec. 5	Mar. 9	Dec. 7
1905.....	May 1	Oct. 17	Apr. 4	Nov. 28
1906.....	Mar. 15	Nov. 18	Mar. 15	Nov. 24
Average.....	Mar. 27	Nov. 23	Mar. 14	Dec. 11

There is in general a well-marked wind movement, the prevailing directions being north and southeast. Violent storms or gales are rare.

Fogs are infrequent and are generally confined to local stream valleys. There is an unusually high percentage of fair weather throughout the year, the average number of clear days at Red Bluff being given as 218, and the average number of rainy days 75.

The climate is, upon the whole, healthful, favorable to crop production, a long growing period, and to the summer curing of fruits. Farming operations suffer comparatively little interruption from frosts or other climatic conditions throughout the year.

AGRICULTURE.

Prior to the discovery of gold there were few white settlers in northern California and agriculture had hardly been attempted. In 1844 the San Buenaventura grant, consisting of 26,632 acres, lying along the western side of the Sacramento River and almost wholly within the limits of the Redding area, had been acquired from the Mexican Government by Maj. P. B. Reading, a central figure in the early settlement of this part of the State. This grant covered the greater part of the most productive section of the Anderson Valley, and the first ranch house was established in this valley near the mouth of Cottonwood Creek. As wild oats and native grasses were abundant the early agriculture consisted mainly in the raising of stock.

The discovery of gold in 1849 and 1850 brought prospectors into northern California, and the town of Shasta was soon after founded and became the center of the mining industry and the principal settlement of this section of the State, although smaller mining towns soon sprang up.

The settlement of the country by prospectors created a demand for hay, grains, fresh and dried fruits, and vegetables, which was only supplied by the limited number who refrained from the search for gold and undertook the production, by primitive methods, of these crops. Fresh vegetables were considered luxuries at this time, and wild hay from the Cow Creek bottoms is said to have been sold in the mining camps for \$150 per ton.

With the building of the railroad in the early seventies the new town of Redding increased in importance and became the metropolis of the district and Shasta was abandoned. Shipment of fruits and farm produce to a distance was now possible and the agricultural resources were rapidly developed. The production of green and dried fruits, consisting of prunes, peaches, and pears, became of much importance in the Anderson Valley. Fruit production was soon taken up by the Happy Valley section, which came into prominence about 1883 and 1884, and the fruit industry has been steadily developed in both places.

In the Anderson and adjacent minor stream valleys prunes are the leading crop, followed by peaches, pears, and, to a much less extent, by grapes and small fruits. Fig trees bear abundantly, but figs are grown only for home use. Alfalfa is produced to a small extent, and with proper care and irrigation should produce 5 tons per acre. Even without irrigation three crops can be cut each season in some sections of the bottom lands well suited to its production. It is usually baled at a cost of about \$2 per ton and generally brings from \$12 to \$15 per ton baled, on the ground. The trucking industry is locally of considerable importance and is largely controlled by Chinese. Grains, consisting of wheat and barley, are grown quite extensively, but much less than in the more southern part of the Sacramento Valley, the greater proportion of these crops being cut green for hay. Dairying and poultry raising are carried on only to a limited extent. The products of these industries, however, bring good prices.

In the Happy Valley district general farming is practiced on a small scale, the valley being essentially a fruit-producing section. Peaches are the leading crop, followed by table grapes, strawberries, and bramble fruits. The peaches are well colored and of particularly fine flavor. Strawberries and bramble fruits yield abundantly.

The value of orchard products for Shasta County, according to the United States Census for 1900, was \$110,276, a sum which has been

greatly increased by more recent development of the fruit-producing industries. The season is in general somewhat later than that of the Santa Clara and more southern Sacramento Valley points. The products are shipped in both the green and dried states, in carload lots, to the Eastern States and to Europe.

Prunes probably constitute the leading crop, the production for the season of 1907 being estimated at 2,200 tons, or 110 carloads at 20 tons per car. The crop usually brings from 3 to 3½ cents a pound. The French prune is the leading variety, and the harvesting begins about September 1, at which time weather conditions are favorable, although showers sometimes occur during the curing period. Peaches are next in importance. The fruit is shipped both green and dried. Most of the smaller express shipments of the green fruit go to northern California and Oregon. The leading varieties are the Muir, Crawford, Imperial, and Foster, the Muir and Crawford predominating. For drying the Muir is reported to be the favorite. The total production of dried peaches in favorable seasons is in the neighborhood of 500 tons.

Pear growing, both for shipment green and for drying, has been an attractive and important industry, but owing to ravages of the blight production in this section has of late fallen off. Many of the orchards have ceased bearing and are being replaced by other crops. This disease, of a bacterial nature, can be checked and eradicated only by persistent and vigorous cutting. Mr. Chris Thorsing, horticultural commissioner of Shasta County, reports excellent success in combating the blight in his orchard, located 5 miles southeast of Anderson.^a With the certainty of a scarcity of pears, the grower who is able to maintain clean and productive orchards of this fruit should be able to obtain a very good profit. Many, however, prefer to replace pear trees with prune and peach trees.

Of the truck crops produced, tomatoes are of particularly fine quality and large size and bear abundantly.

The raising of cattle, sheep, goats, and hogs is an industry of considerable importance and yields good returns, although improvement in breeds and types and in care of the stock is to be desired. The herds are usually grazed in the mountains during the dry summer season.

The adaptability of certain soils to particular fruits is usually well recognized. The prune industry is practically confined to the deeper friable loams of the Sacramento and other stream bottoms. Pears are mostly grown upon soils of a similar character, although those

^a See Report of Thirty-first Fruit Growers' Convention of California, 1906. See Pear Blight, Cause and Preventative, Reprint of United States Department of Agriculture, 1906; Commercial Pear Culture, Reprint of the United States Department of Agriculture, 1900.

grown on the shallower red soils of the Happy Valley section are less succulent and of less vigorous growth, but are not so liable to attack by blight. Peaches are usually planted on gravelly sloping valley lands or on the more elevated shallow soils of the Happy Valley district. It is believed that the influence of the shallower and somewhat less productive soils of this district tends to smaller tree growth and lower yields, but the fruit is exceptionally fine in color, size, and flavor.

Grain and grain hay are grown by a system of dry farming and summer fallowing. Little attempt is now made to grow alfalfa or other deep-rooted crops upon the shallow upland soils, and considerable loss has been met with in the past from planting fruit upon shallow dry lands. Such injury has been particularly apparent in the case of young orchards at first irrigated, but to which water was later denied, or where attempts were made to produce orchard fruits entirely without irrigation in unfavorable locations. Grapes do well upon the deeper phases of the shallow upland soils when irrigated or even without irrigation if intensively and thoroughly cultivated. It is quite possible that a profitable field awaits the development of this industry upon much of the upland part of the area now utilized only for grazing purposes, if attended with care in the selection of soils and systematic and thorough cultivation. .

Rotation of crops and the use of commercial fertilizers are practiced to a limited extent, but barnyard and green manures should be more generally used. The better and more profitable orchards are usually well cultivated, but in many places the importance of frequent and clean cultivation is little appreciated. Throughout the northern part of the area, over which small unirrigated orchard and vineyard tracts are frequently found, much of the loss from the "going back" or dying of the trees or vines is commonly attributed to the poisonous effects of fumes from the smelters of the mining district. The evidence, however, seems to point rather to unfortunate selection of soils and lack of careful cultivation as the real causes of the trouble, although much injury to the native vegetation from smelter fumes has taken place to the northwest of the area.

During the fruit-harvesting season labor is very badly needed and the prices paid are correspondingly high. The work of packing the fruit is done largely by women and children. A large part of the labor of harvesting and handling the fruit in the orchards is generally performed by Indians, who are provided with camping places in or adjacent to the orchards.

Little effort is being made to bring in new settlers or to place farming lands upon the market. Land can be purchased from a few dollars to \$100 or more an acre, depending upon its condition of improvement and adaptability to the production of fruit. Very little

good orchard land is now for sale, and when offered high prices are asked. Unimproved land suitable for alfalfa, truck crops, or orchard crops can be secured at moderate prices. In the Happy Valley district wooded land well adapted to the production of peaches, grapes, or other products of the section can be secured at a cost of \$10 to \$15 or more an acre. While the expense of clearing off the brush and timber is high, stove wood commands good prices and will in many cases repay the cost of clearing.

In the Happy Valley district the size of the farms and orchards is generally small, often consisting of 10, 20, or 40 acres, while in the Anderson Valley and other sections some of the orchard lands are held in larger tracts of 200 acres or more. The average size of farms in Shasta County, according to the United States census for 1900, was 284.3 acres, 77.1 per cent of which were operated by the owners.

In order to increase profits from fruit production, clean and frequent cultivation is necessary so as to conserve soil moisture during the long dry season. Upon the shallower soils of the uplands this is of particular importance, and it is believed some of the failures in the growing of vines and trees might have been avoided had a more thorough system of tillage been followed. The control of diseases and insect pests by pruning and spraying is also necessary in successful fruit production.

SOILS.

The soils of the Redding area fall into three natural divisions, viz, the soils of the uplands, of the valley slopes, and of the stream bottoms. These natural divisions are based upon physiographic, geologic, and agricultural differences, although sharp lines of demarcation do not always exist.

As previously stated, the upland section of the area is elevated somewhat above the Sacramento and minor stream valleys. It is rolling or sloping in character and is dissected by narrow, flat-bottomed gulches and valleys. Except in the vicinity of the Stillwater Plains, the uplands are generally wooded or covered with brush. The section is naturally well drained and somewhat subject to erosions, with consequent loss of organic matter and of the finer mineral materials. The soils, however, are rather heavy in texture and are underlain by dense, compact subsoils containing a large percentage of plastic, tenacious clay and more or less indurated hardpan, which, together with the usual protective covering and the admixture of roots, native grasses, and leaves from forest vegetation, resist the wearing action of water coursing down the slopes.

The soils of the uplands are of deep-red color, gravelly, and in certain sections carry considerable quantities of cobbles and small boulders. The gravels and cobbles are largely igneous and metamorphic material and are usually well rounded or flattened.

The soils of this part of the area are derived mainly from the Red Bluff formation. This formation has a maximum thickness of more than 200 feet and consists of clays, sands, gravels, and cobbles, representing alluvial material deposited over the valley by the Sacramento and its tributary streams in former times, subsequent uplift having elevated the valley and caused the carving of the more recent stream valleys. In the vicinity of the Cow Creek Valley small areas of the upland soils are derived largely from volcanic tuff, ranging in character from light gray and often pumiceous dust and finely abraded material to andesitic boulders, the finer material predominating upon the western side of the valley.^a

Considerable modification in the soil material derived from the Red Bluff formation has recently taken place by the weathering of the gravels, which are frequently so well decomposed as to be readily broken up with a light blow or crushed with the fingers. In parts of the upland plains exposed to the winds much fine material has been blown away, with consequent concentration of the coarser soil particles and gravels at the surface.

The formation of the hardpan, of general occurrence in this group of soils, has taken place subsequently to the original deposition of the soil material. It is due to concentration of the finer clay particles in the subsoils by percolating waters and to the partial cementing of this claylike material by mineral salts, largely silicates and other salts of iron.

This hardpan is red to yellowish-gray in color, from a few inches to several feet in thickness, and is usually found at a depth of 18 inches to 5 feet, although it may occur at greater depths or, upon the other hand, even outcrop at the surface. It may consist entirely of fine material or of a mass of gravels and cobbles inclosed and held together by the finer material.

Three types of soil occur in the uplands—the Redding gravelly loam, the Redding loam, and Rough stony land. These soil types merge gradually into one another and into other adjacent types. The separating of these soils was therefore more or less arbitrary. The soil types differ widely in adaptation to crops and in agricultural value, depending upon adaptability to and the facilities for irrigation, and the occurrence, character, and position of the hardpan.

The soils of the valley slopes consist of three types—two of the Anderson series and one local type, the Bellavista sandy loam. They usually are found adjacent to the soils of the uplands, occupying the higher valley slopes, flat-bottomed gulches, and the valleys of intermittent streams. They are usually gray to reddish gray in color,

^a For further description of this formation and other geologic features, see Redding Folio, Geologic Atlas of the United States, published by the U. S. Geological Survey.

well drained, sometimes slightly gullied, usually wooded or covered with brush, gravelly, and generally free from hardpan.

The soils of this group are formed by direct wash from the adjacent upland slopes and by deposition, in the narrow stream valleys, of material carried down by flood waters, the material having been transported for only short distances. While often of a pervious and leachy character they are usually fairly well adapted to agriculture.

Five types of the stream-bottom soils were encountered, four being soils of the Sacramento series, the remaining one a nonagricultural type, Riverwash. These soils occupy the lower bottoms of the Sacramento and minor stream valleys, varying in texture from coarse sands and gravels to rather compact silt loams, and in color from light gray to dark brown. They are generally well drained but subject to overflow, which in case of some of the types occurs annually. They may be barren of vegetation in spots, but are generally wooded, are often gravelly but free from hardpan.

The soils of this group consist of recent stream deposits, occurring along present or recent stream flood plains, made up of a variety of mineral constituents which have been transported considerable distances. The soil bodies are often small in size, having an elongated outline extending in the direction of stream channels, and are sometimes subject to considerable modification by the erosive effects of floods or the further deposition of material by flood waters. In agricultural importance they range from relatively worthless to the most important and valuable soils of the area.

The following table gives the names and areas of the several soil types shown on the accompanying map:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
• Redding gravelly loam.....	57,216	44.7	Sacramento loam.....	4,480	3.5
Anderson gravelly loam.....	14,528	11.4	Riverwash.....	4,480	3.5
Redding loam.....	14,272	11.1	Anderson fine sandy loam....	3,520	2.8
Sacramento gravelly sandy loam	8,384	6.5	Bellavista sandy loam.....	3,328	2.6
Sacramento silt loam.....	7,680	6.0	Sacramento fine sandy loam..	2,752	2.2
Rough stony land.....	7,360	5.7	Total.....	128,000	.....

REDDING GRAVELLY LOAM.

The Redding gravelly loam varies greatly in texture, structure, depth, and in agricultural importance. Typically it consists of a heavy sticky loam of fine silty texture, red to dark red in color, extending to a depth of 6 to 15 inches, and carrying small to relatively large quantities of subangular, rounded, or flattened cobbles,

pebbles, or fine gravelly material. In limited areas the accumulation of cobbles and gravel in the surface is sometimes excessive, due to the removal of the fine earth by wind action or by erosion.

Although the soil is of a heavy tenacious character, the finer clay material is generally flocculated; which condition, together with the large quantity of gravel, renders the soil friable, readily cultivated, and capable of maintaining an excellent tilth.

A compact and usually adobelike heavy loam of deep-red color, carrying a moderate quantity of gravel, usually underlies the soil at a depth of 6 to 15 inches or less. Beneath this, at a depth of 18 inches to 5 feet, a partially indurated hardpan, of deep-red color sometimes mottled with patches of light-gray clay, is found, although in some places the heavy loam may extend to a depth of 6 feet. The hardpan carries a large quantity of rounded gravel and cobbles, sometimes becoming very dense and hard and resembling conglomerate rock. Outcrops of this material occur along eroded surfaces or as ledges bordering ravines and gulches carved by intermittent streams. Upon the other hand, it often consists entirely of partially indurated or cemented fine claylike material of a soft nature, quite readily penetrated by roots, and frequently easily broken up by the fingers.

The Redding gravelly loam, which is the prevailing soil of the uplands and the most extensive type of the survey, occurs as large bodies occupying much of the northern and western parts of the area, although smaller and irregular bodies are found in various other parts of the uplands. It is of considerable extent upon the higher ancient valley plains and lower foothills bordering the more recent valley of the Sacramento River. The surface is usually gently rolling or gently sloping, often minutely dissected by deep narrow ravines and gulches in which flow intermittent streams. It usually supports a moderately heavy growth of scrub pine, oak, and chaparral brush of the mountains and foothills, mainly ceanothus and manzanita.

The soil is generally well drained, except in local depressions where percolation is hindered by underlying hardpan. The cost of clearing is sometimes high, but is often nearly repaid by the value of the wood removed.

The Redding gravelly loam is derived from early Pleistocene alluvial material deposited in the older Sacramento Valley to a great depth. Owing to its friable structure and heavy subsoil, the Redding gravelly loam has great water-holding capacity. This condition is important and should be augmented by frequent cultivation and the maintenance of a loose surface-soil mulch. Upon the other hand, in some places presence of more or less impervious hardpan strata near the surface arrests percolation of rainfall and decreases the water-holding capacity of the soil. Where the hardpan is very com-

compact roots do not penetrate deeply, rendering the trees and plants particularly sensitive to drought if not irrigated.

The agricultural value of this soil type and its adaptation to crops is thus in a great degree dependent upon the occurrence and position of the hardpan. The soil is not adapted to the culture of prunes or other deep-rooted trees. If the hardpan is nearer the surface than 4 or 5 feet the planting of peaches or vines is attended with considerable risk, unless the layer is soft enough to permit the roots to penetrate it or unless irrigation is practiced. With adequate facilities for irrigation the deeper phases of the soil type are among the most valuable soils for peach culture in the Redding area. Grapes could undoubtedly be produced profitably in such areas in commercial quantities without irrigation by proper care and frequent cultivation during the dry season. Strawberries and bramble fruits yield abundantly, and if irrigated the shallower phases of this soil not adapted to tree fruits could be utilized for these small fruits.

Where orchards are to be set out the shattering of the underlying impenetrable hardpan by the use of moderate charges of explosives is sometimes resorted to in other districts with beneficial results. For this purpose Hilgard^a recommends the use of from one-half to three-fourths pound of No. 2 dynamite placed from 3 to 5 feet below the surface. Enough should be used thoroughly to break up the formation, otherwise in particularly dense strata of considerable thickness the explosion may merely form potholes in which percolating soil waters may collect, and give rise to water-logging and unsanitary conditions about the roots.

The careful examination of the soil with reference to hardpan and adaptability for irrigation is obviously of great importance for fruit growing in the uplands. It may be said, however, that with proper irrigation and cultural methods the fruit industry in the Happy Valley section and in other upland districts where the deeper soils are found is a reasonably safe and profitable investment.

A fine silty phase of this soil type occurs in which surface gravel is absent, the color of the soil ranging from a light yellowish gray to dark brown. This material is shallow and underlain by the typical soil or by hardpan. The surface is frequently puddled and in the dry season baked and checked. Such soil bodies occur upon the elevated upland plains in small potholes or local drainage depressions, usually a few rods in diameter and rarely covering an acre in extent. In such local depressions percolation of rain or drainage waters is usually arrested by the underlying hardpan, leading to the formation of pools during the rainy season followed by a baking of the soil when dry.

^a See "Soils" by E. W. Hilgard, p. 181.

The fine silty material in these depressions is formed by the accumulation of wash from the higher slopes. This phase of the Redding gravelly loam is nearly or entirely barren, and is naturally unproductive owing to poor drainage and unfavorable soil structure. To make these depressions productive they must be drained and the compact puddled condition of the soil alleviated by the addition of large quantities of barnyard manure or other coarse organic matter. In cases where the construction of drains is difficult or impossible, blasting the underlying hardpan strata, as in setting fruit trees, would probably promote percolation of the surface waters and lead to a permanent improvement of the soil.

The results of mechanical analyses of fine-earth samples of the soil and subsoil are given in the following table:

Mechanical analyses of Redding gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17851.....	Soil.....	4.9	8.3	4.8	11.0	13.2	33.9	24.2
17852.....	Subsoil.....	4.9	8.1	5.1	14.6	12.0	32.6	22.0

REDDING LOAM.

The Redding loam is quite similar in texture and color to the Redding gravelly loam, differing mainly in depth to hardpan and in agricultural importance. It consists typically of 8 inches to 12 inches of light-red or reddish-gray loam, usually of fine and somewhat silty texture, but sometimes of light sandy character. It is sticky when wet, somewhat compact in structure, and carries a moderate quantity of small rounded pebbles.

The surface soil is underlain by a heavy, compact, tenacious dark-red clay loam, with little gravel, extending to a depth of 10 inches to 3 feet. In eroded districts the subsoil may appear very close to the surface.

The subsoil is underlain by a clay or sandy clay hardpan, red or yellowish gray in color, mottled with reddish yellow, or by a heavy dark-red or yellow clay containing hardpan layers. The hardpan may or may not contain cobbles or gravel, and is similar to that of the Redding gravelly loam except that it is generally more dense and impervious and usually nearer the surface, sometimes outcropping where the surface soil has been eroded.

The Redding loam occurs in a few moderately extensive bodies in the southeastern part of the area, and merges almost imperceptibly into the adjacent bodies of the Redding gravelly loam or is separated from the lower lying soils of the valley slopes and the stream bottoms by bluff or terrace lines. The areas of this type occupy slightly slop-

ing, treeless sections of the upland plain. The surface is frequently marked by the presence of hog wallows and small drainage depressions occupied by pools of water or by areas of checked and puddled soils.

Redding loam is a sedimentary soil derived from ancient alluvium, once filling the greater part of the Sacramento Valley to a great depth.

Owing to the occurrence of hardpan, the shallow nature of the soil, and to its position in unirrigated sections of the area, this soil type is of secondary agricultural importance, being usually devoted to grazing or to dry farming to wheat. In a few favorably located districts, where the deeper soil is found, small fruits and tree fruits could be profitably grown under irrigation, while table and wine grapes could probably be grown in limited areas by thorough cultivation.

Numerous attempts at fruit culture upon the shallow phase of the Redding loam without irrigation have resulted in failure, led to discouragement, and given an erroneous impression of the Redding area for fruit production.

The average results of mechanical analyses of the fine earth of the soil and subsoil of the Redding loam are given in the following table:

Mechanical analyses of Redding loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17847, 17849.....	Soil.....	4.4	11.4	5.5	13.1	14.4	34.8	16.6
17848, 17850.....	Subsoil.....	3.9	9.2	5.5	12.5	16.7	32.9	19.1

ROUGH STONY LAND.

Rough stony land of the Redding area in the character of the soil material is similar to the bodies of the Redding gravelly loam and the Redding loam into which it merges.

It consists of a few inches to 18 inches or more of a light-red, gray, or yellowish-red to deep-red loam or clay loam carrying a relatively large quantity of waterworn cobbles, small boulders, and gravel. It is underlain by yellow or red to gray clays, indurated clay hardpan frequently carrying an excessive quantity of gravel and cobbles or by beds of volcanic ash and breccias.

It occurs in the northern and northeastern parts of the area as irregular or narrow elongated bodies bordering stream valleys. It is usually separated from the soils of the valley slopes and the stream bottoms by high bluffs and rough, stony slopes. It occupies the higher, hilly, and more deeply dissected sections of the uplands and is generally wooded or covered with more or less brush, although barren in some places.

The Rough stony land is derived from the ancient alluvial deposits of the older valley and from the underlying volcanic muds and breccias.

Owing to the shallow nature of the soil, the presence of hardpan, and the rough, unirrigable, and stony character of the country, it is devoted only to grazing and is generally unadapted to fruits or farm crops.

ANDERSON GRAVELLY LOAM.

The Anderson gravelly loam typically consists of a moderately heavy, sticky loam of light-red color, extending to a depth of 8 to 12 inches and carrying a moderate quantity of small flattened or rounded pebbles, or cobbles, and considerable fine subangular or rounded gravel. It is somewhat compact in structure but friable when cultivated. It is sometimes, however, very gravelly and of lighter color, and in such cases usually grades into the Sacramento gravelly sandy loam. In other locations it is of a fine, silty, compact character, of deeper red color, and grades into the adjacent more elevated soils of the dissected plains and lower foothills.

It is sometimes underlain by rounded cobbles and stream gravels or by heavy, compact clay loam partially indurated and cemented by lime and iron salts, and forming a relatively soft hardpan. Usually, however, it extends to the depth of 6 feet or more, the lower portion of the section being somewhat finer in texture, of more compact structure, and of a deeper red color. Occasionally it is underlain by a compact, deep-red clay loam. The subsoil is often relatively free from gravel and occasional layers or lenses of partially indurated clay or sandy clay material form a soft hardpan quite readily penetrable by roots.

This type occurs in numerous bodies of irregular or elongated outline of moderate size occupying the more elevated valley plains adjacent to the upland soils, or the narrow valleys of small intermittent streams dissecting the uplands. The more extensive and typical bodies occur in the vicinity of Anderson and in the north-western part of the area extending southward from Redding to Clear Creek. Other bodies of more gravelly character and of considerable extent are found in the valley of Stillwater Creek north of Loomis Corners.

The surface is nearly level or gently sloping, with minor irregularities. It is usually well drained and is sometimes scored by erosion or cut by intermittent stream channels.

The Anderson gravelly loam usually supports a more or less vigorous growth of timber and chaparral brush. Except where shallow or of porous, leachy character it is fairly well adapted to irrigation and to crop production.

The Anderson gravelly loam is derived mainly from the adjacent and more elevated formation of the early stream gravels and sediments giving rise to the soils of the uplands. It is of rather recent alluvial origin, the material forming it having been transported only short distances and distributed by the flood waters of intermittent streams. Under irrigation it is well adapted to peaches and grapes, and if well cultivated in favorable locations produces fair yields of these crops without irrigation. Alfalfa is also grown to a very limited extent on some of the irrigated parts of the type. Much of this soil is, however, utilized only for grazing.

With thorough cultivation, supplemented when practicable by irrigation from private reservoirs or by the pumping of ground water, considerable areas of the less gravelly and porous bodies of this soil type, now used only for grazing, can eventually be rendered productive and brought under cultivation.

The results of mechanical analyses of fine-earth samples of the soil and subsoil are given in the following table:

Mechanical analyses of Anderson gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17224.....	Soil.....	5.4	10.5	6.4	21.9	8.1	37.5	9.9
17225.....	Subsoil.....	3.7	11.0	8.9	20.4	6.4	37.6	11.7

ANDERSON FINE SANDY LOAM.

The Anderson fine sandy loam consists typically of a fine sandy loam of light-red to grayish-red color, generally carrying a moderate amount of rather small subangular or waterworn gravel, and extending to a depth of 3 to 6 or more feet. It is somewhat porous and friable and easily maintained in a good condition of tilth. When less than 6 feet in depth it is generally underlain by river sands and gravels, although occasionally by hardpans, clays, or volcanic tuff.

This soil type is not extensive and occurs mainly as narrow, elongated bodies occupying the bottoms and slopes of the narrow valleys of Churn and Stillwater creeks, often grading quite imperceptibly into the adjacent soil types.

The surface is slightly sloping but often scored or pitted by erosion, or marked by minor surface irregularities or low terrace lines. It usually supports a vigorous growth of timber and brush. Parts of the lower lying bodies are sometimes subject to overflow during flood periods.

The soil consists largely of the reworked material derived from the adjacent red soils of the uplands, transported and deposited by the flood waters of the minor streams along which it occurs.

The Anderson fine sandy loam where not subject to overflow is well drained, moderately retentive of moisture under cultivation, and well adapted to the production, with or without irrigation, of grapes, peaches, pears, small fruits, and alfalfa, although irrigation is advised where practicable. It is, when cleared, usually devoted to dry farming to grain, or to peaches, prunes, pears, and grapes. The yield is generally somewhat less than upon the soils of the Sacramento series, but the fruits produced are of excellent quality.

A considerable part of this type is still uncleared of timber and brush and could be brought under profitable cultivation.

The results of mechanical analyses of fine-earth samples of the soil and subsoil of the Anderson fine sandy loam are given in the following table:

Mechanical analyses of Anderson fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17856.....	Soil.....	0.9	4.0	5.2	29.8	19.0	31.6	10.2
17856.....	Subsoil.....	1.1	6.5	8.4	33.6	14.6	26.4	9.9

BELLAVISTA SANDY LOAM.

The Bellavista sandy loam is subject to wide variation in texture, depth, and character of underlying material. Typically it consists of a light ash-gray sandy loam of rather fine texture and of somewhat sticky character, extending to a depth of 1 to 3 feet, and underlain by a compact, sandy clay of adobelike structure. In the vicinity of adjacent hill slopes it is generally gravelly, the gravel consisting of small subangular particles to large rounded cobbles, and the soil is of a slightly coarser and lighter character, occasionally extending to the depth of 6 feet or more.

Where it merges into the Redding gravelly loam and the Anderson gravelly loam it has a reddish color and its structure is more compact and its texture is finer and heavier. In the valley bottoms it is often fine and somewhat silty in texture, and compact in structure, while upon the more elevated slopes the sandy material is rather coarse and the soil sometimes extends to the depth of 6 feet or more. The more elevated bodies are frequently underlain by a coarse, partially indurated sandy clay or clay hardpan, or by beds of volcanic ash and tuff. The soil is generally friable under cultivation, although numerous, small, puddled depressions of heavy compact structure and fine texture occur.

The Bellavista sandy loam is not extensive, occurring only in the northeastern part of the area in the depression of the Cow Creek Valley, as irregular bodies adjoining outcrops of volcanic ash and

tuff. It occupies nearly level or gently sloping narrow valley plains or lower rolling hill slopes. It is generally well drained and often covered with a heavy growth of oaks or chaparral. The more elevated bodies are sometimes broken by outcrops of the underlying material or marked by the presence of cobbles and bowlders and are shallow and unproductive.

The Bellavista sandy loam owes its formation to the erosion of the adjacent beds of volcanic ash and tuff and the distribution by intermittent streams of this material mingled with gravels and other soil material derived from the more elevated soils of the uplands.

The lower bodies are generally devoted to grazing or to dry farming to grain, although such areas could probably be planted to alfalfa or to other irrigated crops or fruits. The latter are produced only to a limited extent upon this soil type. The more elevated areas are usually suited for and devoted only to grazing.

The results of mechanical analyses of fine-earth samples of the soil and subsoil are shown in the following table:

Mechanical analyses of Bellavista sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17853.....	Soil.....	0.0	6.6	20.1	44.6	4.8	15.0	7.9
17854.....	Subsoil.....	4.0	12.1	6.6	17.0	13.0	31.2	15.8

RIVERWASH.

Riverwash of the Redding area varies greatly in character of material, consisting of coarse to fine river sands, waterworn gravels, and cobbles, and extending to the depth of 6 feet or more. Generally these materials are more or less intermingled, and either the sandy or gravelly material may predominate or may be nearly lacking in local areas.

It is an inextensive type, occurring near or occupying present or abandoned stream channels of the Sacramento River and its tributary creeks, the more extensive bodies lying in the vicinity of and southeast from Redding. The lower lying bodies of finer texture occurring adjacent to the Sacramento River frequently support a moderately heavy or dense growth of the brush and timber usually found in the stream bottoms. The surface is frequently more or less scored by erosion and the type is generally subject to overflow during flood periods.

It is of recent alluvial origin, and, owing to its position and its loose, leachy, or stony character, is unsuited to crop production, being of no agricultural value except for grazing.

SACRAMENTO GRAVELLY SANDY LOAM.

The Sacramento gravelly sandy loam varies considerably in the quantity and character of its gravel content. From 10 to 30 inches it consists of a light-brown or sometimes slightly reddish-brown, light sandy loam or slightly sticky sandy loam. Subangular or rounded particles of fine gravel and sometimes large quantities of flattened or waterworn pebbles or cobbles of many varieties of rocks, those of volcanic and metamorphic origin predominating, are found mingled with the finer materials.

It is underlain by beds of waterworn cobbles and gravels intermingled with sands and finer sediments. Both soil and subsoil have an open, porous structure and leachy character.

This soil is in general of somewhat lighter color and heavier texture than the Sacramento gravelly sandy loam of the Colusa area.^a

It occurs as inextensive and irregular bodies adjacent to the Sacramento River, as long, narrow strips in the bottoms of the smaller valleys, and in the numerous gulches and ravines traversing the higher valley plains and lower foothills, extending sometimes for a distance of several miles and being cut by meandering courses of intermittent streams. The most extensive body, which is, however, intermingled somewhat with the heavier soil material of the Anderson gravelly loam, and is not entirely typical of the Sacramento gravelly sandy loam, occupies a large part of the Clear Creek Valley. The surface is often uneven and eroded by flood waters and frequently supports a moderately heavy growth of small timber and brush. It is of recent alluvial origin, being a deposit from the flood waters of streams.

When well irrigated, fair yields of peaches or other fruits and alfalfa may be obtained on the heavier phases of the soil. It is, however, of slight agricultural importance, the heavier and more productive bodies being marked by very gravelly, unproductive spots, and it is generally utilized for grazing.

The results of a mechanical analysis of a fine-earth sample of the soil is given in the following table:

Mechanical analysis of Sacramento gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17859.....	Soil.....	8.0	15.0	9.0	21.4	15.4	23.9	7.5

SACRAMENTO FINE SANDY LOAM.

The Sacramento fine sandy loam consists typically of a loose, uniform light gray, micaceous fine sandy loam, usually but not always

^a See Soil Survey of the Colusa Area, California. Field Operations, Bureau of Soils, 1907.

extending to a depth of 6 feet or more. When less than 6 feet in depth it is underlain by river sands and gravels. In some places it becomes somewhat darker in color, resembling the Sacramento silt loam, and the gradual merging of these two soil types renders indefinite the exact boundaries between them. The soil is frequently gravelly, the gravel consisting of either waterworn pebbles or cobbles. Some bodies found along the Sacramento River or its overflow channels are coarse in texture and carry considerable gravel.

The subsoil consists of gravels, rounded or flattened by stream activity, sometimes intermingled with coarse to fine sand. In places where erosion has been heavy this subsoil outcrops at the surface in streaks, and is worthless except for grazing.

The Sacramento fine sandy loam appears only as small irregular or narrow elongated bodies lying near the stream channels of the Sacramento River and a few of its tributaries, and merges into the Sacramento silt loam or other adjacent soil types. In extent and in the agriculture of the area it is one of the less important types. It frequently supports a considerable timber growth and is often scored by erosion and subject to overflow. It is of recent alluvial origin, the material being transported for considerable distances and deposited by the shifting of streams in time of floods.

The loose, porous nature of this soil allows good drainage where not subject to overflow. The same characteristics render it easy to maintain in good tilth. It does not retain very much moisture, and frequent cultivation during the dry season is of great importance in the successful growing of fruits. Where irrigation is adequate the more elevated bodies of finer texture are well adapted to alfalfa, or to peaches, prunes, or vegetables. This soil is generally used for pasture, although fruits and alfalfa are grown to a limited extent.

The results of mechanical analyses of the fine earth of the soil and subsoil of the Sacramento fine sandy loam are given in the following table:

Mechanical analyses of Sacramento fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17152.....	Soil.....	0.0	0.9	3.9	52.3	12.9	24.6	6.0
17153.....	Subsoil.....	.0	.3	2.2	41.4	12.1	37.9	6.7

SACRAMENTO SILT LOAM.

The Sacramento silt loam varies in color from a light or somewhat yellowish-brown to dark-brown or nearly drab. It consists typically to 6 feet or more of a friable, moderately porous micaceous loam to silt loam, often gravelly, the gravel consisting of small flattened or well-rounded pebbles.

It is of moderate extent, and in the southern half of the area is the prevailing type of the stream bottoms. The soil bodies are usually elongated in outline and extend parallel to the courses of the Sacramento River and its tributaries. It supports a moderately heavy native growth of oaks, or in the river bottoms the typical "jungle" growth of cottonwood and sycamore trees, with a dense undergrowth of bushes and vines. It is generally well drained, although occasionally subject to overflow by floods. The surface is usually level and well adapted to irrigation, but is sometimes marked by slight unevenness due to erosion by flood waters.

The Sacramento silt loam, like the other soils of the Sacramento series, is of alluvial origin, the soil material having been transported and deposited by stream flood waters.

It is friable under cultivation and is easily maintained in good tilth, and in such condition has well-marked moisture-retaining properties. Owing to its deep friable nature and productive character, it is well adapted to the growing of prunes, peaches, pears, grapes, alfalfa, and vegetables, the two last-mentioned crops being more successfully grown upon the lower lying and more moist bodies, or where the soil is irrigated.

Prunes, peaches, and pears are the leading crops grown upon the Sacramento silt loam, the more productive orchards being in a high state of cultivation.

This soil has played a very important part in the development of the fruit industry in the Anderson Valley and is the leading prune soil of the area.

The results of mechanical analyses of fine-earth samples of the soil and subsoil are given below:

Mechanical analyses of Sacramento silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17150.....	Soil.....	0.1	1.2	3.0	25.4	11.8	47.9	10.3
17151.....	Subsoil.....	.0	.7	2.9	26.3	12.8	47.5	9.2

SACRAMENTO LOAM.

The Sacramento loam is typically a light brown to drab, moderately sticky loam extending to a depth of 6 feet or more. In its native condition it is somewhat compact in structure and bakes slightly during the dry season, but under irrigation it is friable and capable of maintaining a good tilth. It is not extensively developed in the Redding area, being found only as a few small irregular bodies, the largest of which occurs near the center of the area.

The surface is nearly level or gently sloping, and the soil is generally well drained, except in the case of some of the smaller bodies subject to occasional overflow, which frequently support a heavy growth of timber and brush.

In origin and in mode of formation it is similar to the other soils of the Sacramento series.

It is well adapted to prunes, pears, and under irrigation to alfalfa, sugar beets, and truck crops. It is principally devoted to grazing and dry farming to grain and is well suited to the culture of irrigated crops. It is the most promising soil type of this area for the production of alfalfa and sugar beets.

The following table gives the results of mechanical analyses of the soil and subsoil of the Sacramento loam:

Mechanical analyses of Sacramento loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17864.....	Soil.....	0.1	0.9	2.1	19.2	21.7	42.2	13.6
17865.....	Subsoil.....	.0	.9	1.8	22.1	30.2	32.0	13.4

IRRIGATION.

The development of irrigation in the Redding area has been somewhat retarded and is practiced only to a limited extent. In the uplands this is due largely to the expense of constructing distributing systems in the hilly sections or to a limited water supply. In the deeper moist soils of the nearly level valley districts irrigation is generally unnecessary for the profitable production of the leading fruit crops. The extension of irrigation facilities is, however, greatly to be desired, and no insurmountable difficulties present themselves, at least in the most important sections of the area.

While in the Happy Valley and other upland districts attempts have been made from time to time to produce fruits without irrigation, failures have resulted and the necessity of irrigation for successful fruit growing is now generally recognized.

The Happy Valley district is the most extensively irrigated section of the area. The water is obtained from the creeks of the adjacent mountains upon the west and is distributed by a private company, largely by means of a system of small canals and ditches formerly used for conveying water for mining purposes. The water is of good quality for irrigation. On account of the extension of the fruit industry in this section, however, the water supply during the dry summer months has become entirely inadequate, and as the cost of water is increasing much dissatisfaction is expressed by patrons of the system. This condition has created a demand for an investigation of

water resources and the possibilities for the storage of water in reservoirs and its distribution under the Federal reclamation act. Some preliminary investigations looking to this end have consequently been carried on. A complete irrigation system for this section would call for long, sinuous canals excavated through shallow rocky soils and in the more hilly districts for the construction of expensive flumes or pipe lines. Owing, however, to the ordinarily impervious nature of the subsoils, only slight loss would result from seepage. Where the production of choice fruits plays so important a part as it does here, the extension of irrigation facilities should commend itself as a field for investment of private capital or as worthy of Federal aid, even where the first cost of installing irrigation works is relatively great.

In the valley districts only a few small isolated irrigation systems exist. These consist of an inextensive gravity system, irrigating a few small fruit and alfalfa tracts, in the vicinity of Bellavista, along the western side of the Cow Creek Valley and a number of pumping plants, under private ownership, which irrigate a few acres of vegetables or alfalfa along the Sacramento River and its tributary creeks from which water is taken. The operation of these plants has generally proved profitable. The available supply of water for pumping in Stillwater Creek and other small streams during the summer months is limited, though there is a considerable underflow in the channels of the streams which might be rendered available by sinking wells or pits. One small steam pumping plant in the Stillwater Creek bottoms used for irrigating a small tract of alfalfa is reported to be capable of throwing 1,000 gallons per minute.

Throughout the valley of the Sacramento and along some of the tributary creeks considerable bodies of gently sloping land, admirably adapted to irrigation but now devoted only to grazing or to dry farming to grains, could be furnished with water by gravity systems or by pumping, so that the production of truck, alfalfa, sugar beets, or forage crops on the deep valley soils would be greatly increased. Near the central part of the area irrigation of the deep, gently sloping lands is quite feasible, and its development should be encouraged. It is probable that irrigation in the valley as well as in the upland portions of the area will be given greater consideration in the future.

SUMMARY.

The Redding area has an extent of about 200 square miles and lies at the northern extremity of the depression of the Sacramento Valley, being separated upon the south from the Sacramento Valley proper by a low ridge of hills. It consists of rolling or dissected uplands, often wooded, traversed by the Sacramento River and its tributary creeks. The greater part of the area is occupied by the upland section.

The agricultural population of the northern and northeastern parts is relatively sparse, the most important agricultural districts of the area consisting of the Anderson Valley district and the Happy Valley district of the uplands, lying in the southwestern part of the area.

Transportation facilities are fair and the mining centers upon the north afford excellent local markets for agricultural products.

The summers are long, warm, and dry, and the winters mild and moderately rainy. The climate is generally healthful and favorable to crop production and to the curing of green and dried fruit products.

The settlement of the Redding area was due mainly to the mining excitement of 1849-50, the early agricultural products being grown to supply demands of the mining camps. The construction of the railroad furnished an outlet for agricultural products and the production of fruits soon became an industry of considerable commercial magnitude, developing first in the Anderson and later in the Happy Valley district.

Green and dried fruits are the principal products, prunes and peaches leading in commercial value, followed by grapes and small fruits. Alfalfa is grown to a limited extent and commands excellent prices. Grains are produced on a considerable scale under the dry farming system, but the bulk of the crop is cut green and cured for hay.

The growing of pears has been a profitable and important industry, but is now suffering a decline owing to the ravages of the pear blight, which can be checked and eradicated only by the systematic and persistent cutting and the removal of the infected parts of the tree.

The production of prunes is confined to the deeper, moist soils of the valleys, while peaches find most favorable conditions upon the gravelly and more shallow lands of the valley slopes and uplands. In the upland sections there is some possibility that commercial grape culture may be extended to the deeper soils without the need of irrigation if thorough cultivation is practiced.

Many failures in the growing of grapes and tree fruits have resulted from the selection of thin and stony soils, the lack of irrigation facilities, and lack of proper care and cultivation.

Labor conditions during the fruit-harvesting season sometimes become serious, labor frequently being scarce and commanding high wages.

Little effort is made to induce settlers to enter the area or to effect the subdivision and sale of the larger tracts of farming lands. Improved valley lands may be purchased, however, at fair prices, while in the upland section in the Happy Valley district wooded lands can be bought at a low figure. The cost of clearing is high and the products must be hauled some distance to market or to the nearest shipping point, but the cost of clearing is largely offset by the value of the wood removed, and the country roads are generally in good condition during the fruit-shipping season.

The soils of the area fall into three natural divisions, viz, the soils of the uplands, of the valley slopes, and of the stream bottoms.

The soils of the uplands are generally red in color and of moderately heavy texture, somewhat gravelly or stony, and underlain by adobe subsoils. Where clay-iron hardpans are found the soils are frequently shallow and unproductive, and are derived from ancient valley sediments modified by subsequent weathering, by erosion, and by wind action. The three upland soil types consist of two soils of the Redding series and one nonagricultural type—Rough stony land.

The surface of the Redding gravelly loam is generally wooded or covered with brush and is of rolling or sloping character, dissected by numerous stream valleys. It is the prevailing soil type of the uplands, and varies greatly in agricultural value and in adaptation to crops. Where the hardpan does not too closely approach the surface and where irrigable, as in the Happy Valley district, it is especially adapted to the production of peaches, grapes, and berries, or to grape culture without irrigation. Peaches are the leading fruit crop of this soil type.

The Redding loam is similar in general features to the Redding gravelly loam, but is usually of somewhat lighter texture, and the underlying hardpan is of more general occurrence and lies nearer the surface. It is a relatively inextensive soil, and owing to its thin character and to the lack of irrigation facilities is usually devoted only to grazing or to dry farming to grains, and is of secondary agricultural importance.

Rough stony land is similar in character of soil material to the soils of the Redding series, but owing to the occurrence of hardpan, its rough topography, stony character, and lack of irrigation facilities, it has no present agricultural importance.

The soils of the valley slopes consist of two types of the Anderson series and the Bellavista sandy loam. These are formed mainly by wash from adjacent upland slopes and are fairly well adapted to peaches, pears, grapes, and, under irrigation, to alfalfa.

The Anderson gravelly loam occurs upon the gently sloping higher valley plains adjacent to the soils of the uplands or in narrow valleys of minor intermittent streams. Several productive orchards occur upon this soil type.

The Anderson fine sandy loam occurs as small, narrow bodies in the vicinity of Churn and Stillwater creeks. The surface is frequently uneven and often thickly covered with brush and timber. It is an inextensive soil type, but supports a number of small orchards producing a good quality of peaches, prunes, and pears.

The Bellavista sandy loam occurs as inextensive bodies only in the northeastern part of the area in the vicinity of Cow Creek, and is usually devoted only to grazing or to dry farming to grain.

The soils of the stream bottoms consist of four types of the Sacramento series and of one nonagricultural type—Riverwash. They consist of recent alluvial stream sediments occupying the lower parts of the valleys.

Riverwash is a mixture of fine to coarse sands, cobbles, and gravels, occupying old or present stream channels. It is a relatively inextensive soil type, is subject to overflow, and is of no agricultural importance.

The Sacramento gravelly sandy loam occurs as inextensive bodies in the vicinity of the Sacramento River and as narrow strips in gulches and in the valleys of intermittent streams. It is usually devoted to grazing and is of minor agricultural importance, although fruit is produced to a small extent in favorable localities, and alfalfa might be grown under copious irrigation.

The Sacramento fine sandy loam occurs as small bodies in the vicinity of the Sacramento River and its tributary creeks. While under irrigation it is fairly well adapted to alfalfa and to fruits, it is usually devoted to grazing and is of secondary agricultural importance.

The Sacramento silt loam is easily maintained in a fine condition of tilth and is well adapted to the production of prunes, peaches, pears, grapes, vegetables, and alfalfa. It is the leading soil type of the area in the production of prunes, and is in point of extent and agricultural value the most important soil of the stream bottoms.

The Sacramento loam is friable under cultivation, occurring only as rather small bodies near the center of the area. While it is usually devoted only to pasture or to dry farming to grains, it is excellently adapted to irrigation and to the culture of alfalfa, sugar beets, or other irrigated crops, as well as to fruits.

The development of irrigation has, owing to natural difficulties, been somewhat slow. In the valley districts irrigation is usually unnecessary in the production of fruits, but upon the upland part of the area it is essential to successful and profitable fruit culture.

The Happy Valley district is the most extensively irrigated section of the area, but the present system is inadequate and the cost of water is high. The extension of irrigation systems in this district will be costly, but as the profits realized from the intensive production of choice fruits will be large, further development of irrigation should be undertaken.

In other upland districts of the area water resources are limited and the development of irrigation improbable.

In the valley sections there are a few small irrigation systems operated by gravity or by pumping, but the production of vegetables and alfalfa could be greatly increased by their extension.

THE SOILS OF BUTTE VALLEY, SISKIYOU COUNTY,
CALIFORNIA.

By W. W. MACKIE.

INTRODUCTION.

Butte Valley lies in eastern Siskiyou County, Cal. Its northern limits extend to a steep range of hills about 2 miles south of the Oregon line. On the eastern side of the valley the low Sheep Mountains separate it from Lower Klamath Lake, while on the west

the higher Siskiyou Range separates it from the Shasta Valley. These ranges of mountains entirely encompass the valley, joining the spurs of Mount Shasta at the southern extremity. Over 100,000 acres are thus inclosed in a level basin which was at one time a lake. From Mount Shasta, 40 miles to the south, arise the streams which form Butte Creek, which enters the valley at its southern end, furnishing irrigation water for several hundred acres of alfalfa, timothy, clover, and grain crops. Another small stream, Praether Creek, flows into the

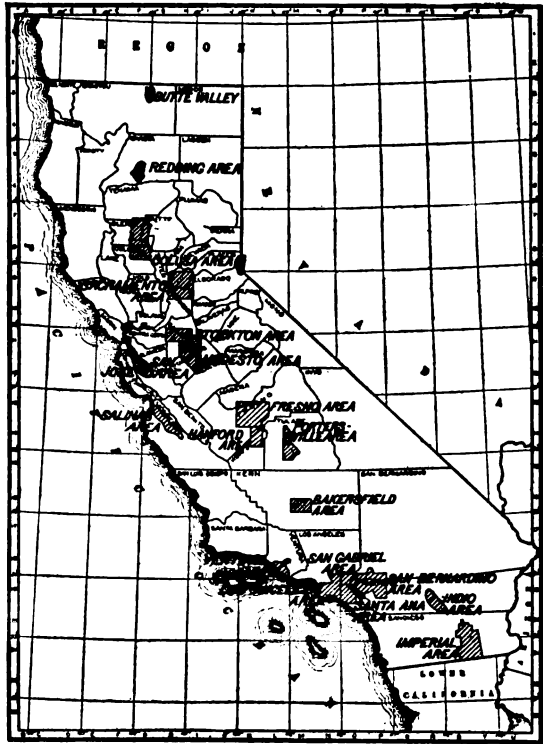


FIG. 34.—Sketch map showing location of Butte Valley, California.

western side of the valley from the Siskiyou Mountains, furnishing irrigation water and electric power for a dairy situated there. Butte Creek sinks soon after entering the valley, but Praether Creek flows directly into the southern end of Butte Lake. Butte

Lake is situated in the western-central part of the valley and covers between 5,000 and 10,000 acres, according to the variation in the seasonal rainfall. Its waters are supplied by the run-off from the surrounding mountains, numerous springs, Praether Creek, and the

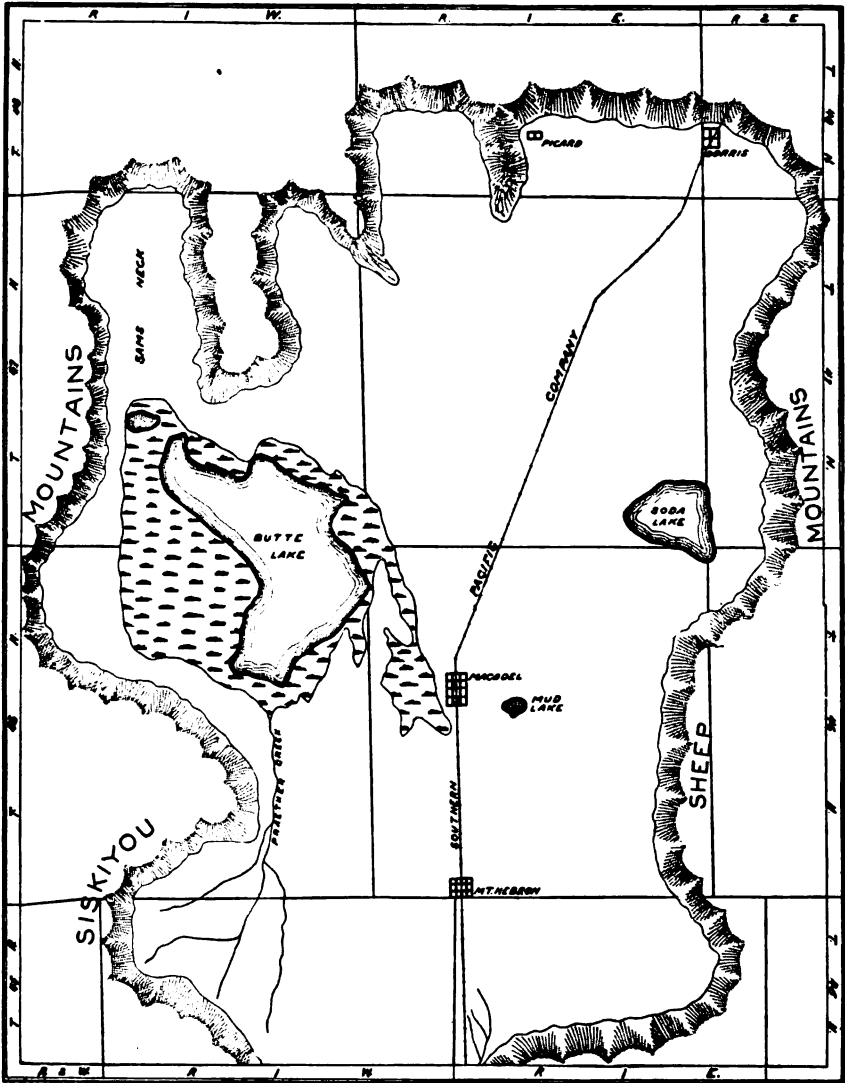


FIG. 35.—Map of Butte Valley.

subterranean waters from Butte Creek sink. Butte Lake has no outlet, but at one time undoubtedly flowed out through a little valley called Sams Neck into the Klamath River to the north. A later flow of lava shot across this arm, completely choking it and effectively

shutting off the outlet. Other lakes and ponds occur, namely, Alkali or Soda Lake, in the eastern part of the valley, covering 600 or 700 acres, and Mud Lake, just east of Macdoel, occupying about 40 acres. Springs burst forth from the basalt outcrop near the town of Macdoel, furnishing an abundance of excellent water.

Underground water, on account of the inclosed position of the valley preventing any sort of outlet, is found at a shallow depth, varying from 1 to 10 feet of the surface over the entire valley. It is uniformly abundant.

The timber and vegetation of the area are characteristic of this portion of California. The high Siskiyou Mountains are covered with a heavy growth of yellow pine, Douglas spruce, white fir, incense cedar, and tamarack pine, together with trembling aspen, maple, oak, wild cherry, and plum. The Sheep Mountains, to the west and north of the valley, are sparsely covered with juniper. Sagebrush (*Artemisia tridentata*) completes the covering of these hills and extends over the valley, except where it is too wet. Here it gives way to rabbit brush and occasionally to greasewood (*Sarcobatus vermiculatus*). The swamps are covered with tule-grass (*Juncus*), which furnish good grazing and wild hay. Butte Lake is full of tules (*Scirpus*) in its deepest portions, with tule-grass (*Juncus*) or open water in the shallows. The southern end of the valley is partly covered by yellow pine, in which several sawmills are operating. Large areas of wild currant appear on the high sandy soils about Macdoel. A number of wild grasses grow throughout the brush area, furnishing excellent feed for stock.

CLIMATE.

The climate of Butte Valley conforms closely to that of the Rocky Mountain and Great Basin regions in the States of Oregon, Washington, Idaho, Utah, and Colorado. The valley is situated almost exactly in 122° west longitude and 42° north latitude, at an altitude of about 4,200 feet above sea level. At this altitude the climate is cool in summer, with occasional snows in winter, and a large number of clear, sunny days throughout the year. The rainfall at Yreka, the county seat of Siskiyou County, situated 40 miles west of Butte Valley, averages, for twenty-eight years, 16.91 inches. At Klamath Falls, about 20 miles north of Butte Valley, the rainfall averages about 15 inches annually, varying between 20 inches for very wet years and 12 inches for dry years. This is probably very close to the rainfall for Butte Valley, but as no records have been taken until recently, no local data are available. The heaviest fall of rain occurs during the winter months, while the rainfall for the summer months of June, July, August, and September averages about half an inch a

month. This summer rain is very beneficial to grass, forage crops, potatoes, and grain crops, which are planted during March and April, frequently enabling them to mature without irrigation late in summer or during September.

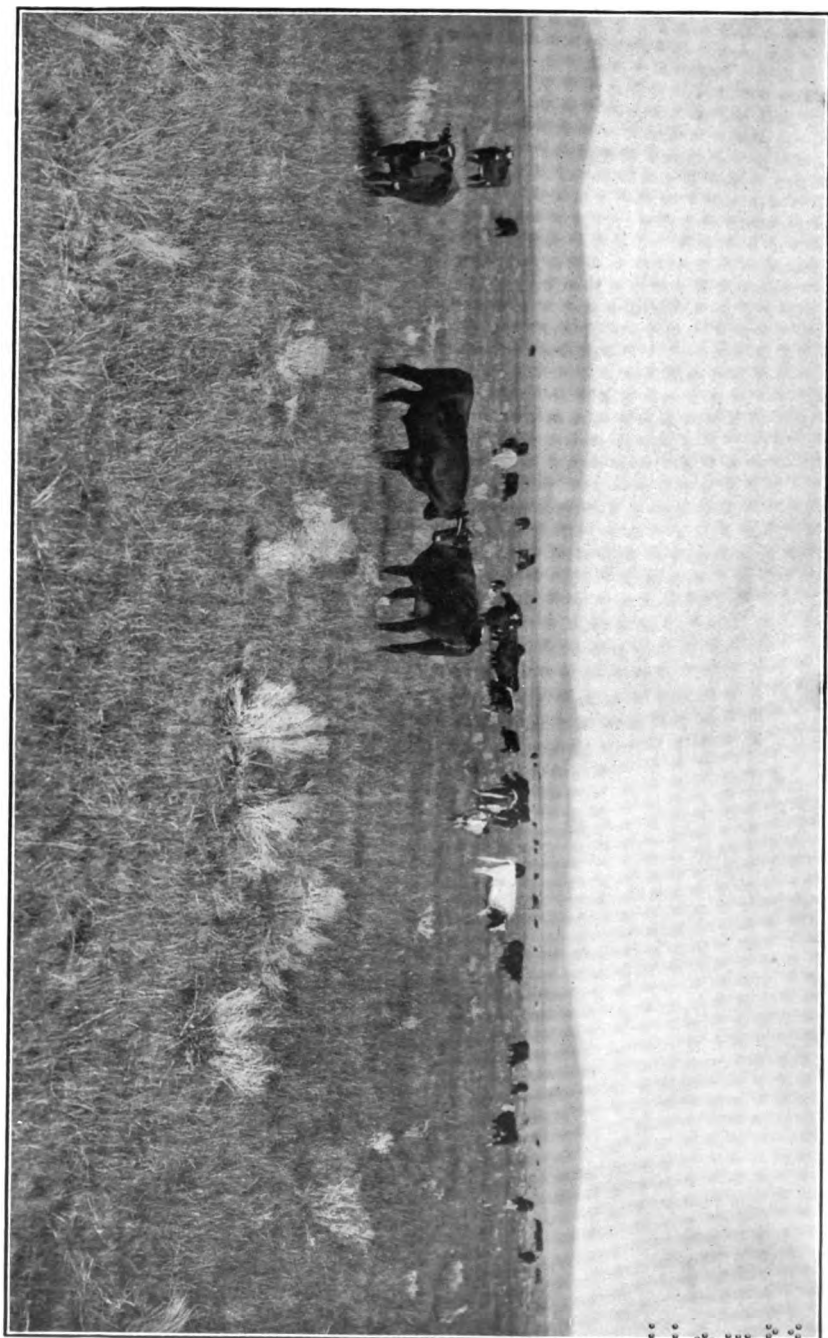
Like similar areas in this elevated region, frosts occur late in the spring and early in the fall. During the comparatively short summer season the growth of all vegetation is extremely rapid. This is due to the long, bright, clear summer days and uniformly warm temperature at this season. Oats and rye sown in April and May are ready for thrashing by September, and fruits are little, if any, behind those grown in warmer localities. The clear summer atmosphere produces a brilliant coloring in the apple and adds to its bright, clean appearance. Like similar areas of high altitude in Colorado and elsewhere, the sugar content of the sugar beet should be greatly increased. Plant diseases are rare, and crops are usually healthy and vigorous.

SETTLEMENT.

The settlement of Butte Valley began about 1880, when the abundance of feed, wood, and water attracted cattlemen thither. Large tracts were then bought for nominal sums and divided into half a dozen large cattle ranches, with headquarters in the edge of the timber on the sides of the valley. Considerable land on the higher, sloping, drier portions of the valley was not included and was later homesteaded by settlers, who began the cultivation of grain crops. This condition existed until a branch of the Southern Pacific Railroad was constructed through the valley to Klamath Falls, where the Klamath Falls reclamation project is in course of construction by the Federal Government. On the approach of the railroad some of the large ranches were subdivided and sold to actual settlers. This impetus to permanent agriculture led to the rapid erection of three towns in the valley—Dorris at the northern extremity, Mount Hebron at the southern end, and Macdoel in the central portion. Although a few months only have elapsed since the first small tracts were sold, the valley is dotted with homes.

SOILS.

The basaltic lava cap covering northeastern California, northern Nevada, Idaho, eastern Oregon, and eastern Washington, poured forth from many volcanoes, among which were Mount Shasta, Goose Nest, Mount Pitt, and Crater Lake, in the immediate vicinity of Butte Valley. Many rich and fertile valleys are found through this volcanic region, such as the Yakima and Wenatchee valleys of Washington;



TULE-GRASS SWAMP, CHARACTERISTIC OF SANDY LOAM SOILS NEAR BUTTE LAKE.

The eastern part of the lake contains soils of a gray puddled heavy loam character, which in spots grade into a gray clay loam. The subsoil is usually heavier in texture and lighter in color. Where covered with water, no injurious quantities of alkali are found except in the small clay loam spots. Along the borders of this soil, above the water line, alkali in moderate quantities sometimes occurs. The agricultural value of this heavy soil is readily determined by the growth of tule-grass (*Juncus*) which covers the better portions. The open water covers the poorer soils. The soil is adapted to the crops suitable to the other loam soils when properly drained and farmed.

The fertility of the soils of Butte Valley is everywhere evidenced by abundant crops of fruit, grain, grasses, and vegetables. The native vegetation, consisting of wild currant bushes, sagebrush, marsh-grass, buffalo-grass, and many other plants, shows all the soils to be productive, with the exception of those limited areas where alkali is found.

In the lower parts of the valley, as well as in the neighborhood of the lakes and swamps, quantities of rotted vegetable matter have produced large amounts of humus, or organic matter, in the loam soils found there. This humus, or organic content, ranges as high as 14 per cent in some of the muck soils. In the sand and sandy loams the humus is abundant and can usually be found to a considerable depth, imparting a dark color to the soil.

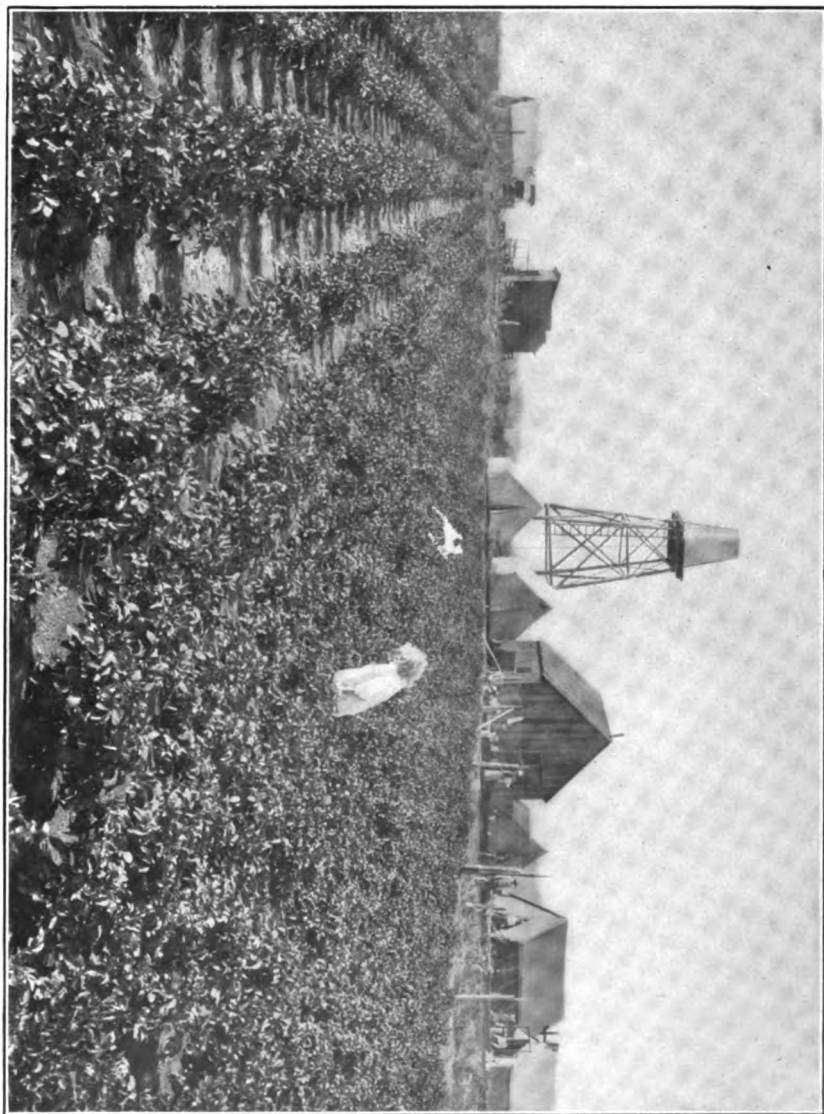
The formation of humus is greatly facilitated by the presence of an abundance of lime, which is everywhere common in the soils and subsoils. In the heavier soils lime is often concentrated about the third foot, occurring through 18 inches of the soil column. It also occurs in heavy subsoils in the form of concretions or small lenses.

In the sands and sandy loams lime is concentrated in the soil at a depth varying from 3 to 8 feet. This marl varies in thickness from one-half inch to 6 inches, although in the lower depths of the subsoil it sometimes occurs in strata 2 or 3 feet thick, when it includes large proportions of tufa. It is usually very soft and readily penetrated by roots and water.

The quantities of mineral plant food contained in the various soils of Butte Valley were determined by the official method, and the results are given in the table on page 13.

HARVESTING THE FIRST CROP OF RYE WHERE SAGEBRUSH GREW IN APRIL.





A POTATO FIELD ON LIGHT SANDY SOIL.

In many years no irrigation is necessary to insure heavy yields.

Results of chemical analyses of soils from Butte Valley, California.

Sample No.	Location.	Description.	Potash (K ₂ O).	Phosphoric acid (P ₂ O ₅).	Lime (CaO).	Organic matter.
			<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
a 17958	NW. sec. 4, T. 46 N., R. 1 W.	Soil, sandy loam, 0 to 12 inches.	0.29	0.06	.....	.....
17960	do.....	Subsoil, sandy loam, 24 to 36 inches.	.91	.08	.....	.....
17962	NW. sec. 36, T. 48 N., R. 1 W., near Dorris.	Soil, sandy loam, 0 to 12 inches.	.48	.06	1.79	.....
17965	do.....	Subsoil, sandy loam, 36 to 48 inches.	1.20	.11	3.98	.....
b 17968	NW. $\frac{1}{2}$ sec. 36, T. 46 N., R. 2 W.	Soil, sand, 0 to 12 inches.....	.34	.03	.....	.....
17971	do.....	Subsoil, sand, 36 to 48 inches.	.19	.04	.....	.....
17974	NW. $\frac{1}{2}$ sec. 5, T. 45 N., R. 2 W.	Soil, brown loam, 0 to 12 inches.	1.20	.21	1.92	.....
17977	do.....	Subsoil, brown loam, 36 to 48 inches.	1.33	.12	2.03	.....
17980	N. $\frac{1}{2}$ sec. 9, T. 47 N., R. 1 W.	Soil, gray loam, 0 to 12 inches.	1.01	.09	1.61	.....
17983	do.....	Subsoil, gray loam, 36 to 48 inches.	2.55	.08	2.06	.....
c 17986	SW. corner of Butte Lake.	Soil, muck, 0 to 12 inches....	1.23	.29	.....	13.71
17987	do.....	Subsoil, muck, 12 to 24 inches	.55	.13	.....	10.31
17226	4 miles NE. of Macdoel.	Soil, gray, fine sandy loam, 0 to 8 inches.	1.04	.10	.....	.....
17227	do.....	Soil, silt loam, 0 to 24 inches.	2.42	.28	.84	.....
17228	do.....	Subsoil, silt loam, 24 to 48 inches.	1.85	.17	1.88	.....
17729	do.....	Deep subsoil, silt loam, 48 to 72 inches.	1.47	.27	.89	.....

a Distinctive vegetation, wild currant.

b Distinctive vegetation, pine.

c Tule swamp.

ALKALI IN SOILS.

After a careful study of the soils of the valley, it is very apparent that accumulations of alkali are not common, and, except for small areas in the immediate neighborhood of the lakes, it is not present in sufficient quantity to affect materially such crops as grain, clover, alfalfa, and sugar beets. Many analyses developed the fact that the alkali in the valley, on account of the predominance of lime carbonates, is largely black alkali, but in the sandy soils is nowhere deep-seated and in fact is found mainly in the first 2 inches in the first foot of soil or directly over the water table in a thin stratum in the subsoil.

On the loams at the north end of the Butte Valley alkali sometimes appears as a black crust in bare spots a few feet across, or on the sandy

loams on the borders of swamps, in white incrustations at the roots of the swamp grasses. Analyses of the soils in this locality and the growth of native vegetation and crops show only small quantities accumulated almost entirely in the surface crust. Such surface accumulations will yield at once to a system of flooding and drainage.

On the loams and heavier soils, alkali is concentrated below the surface in the heavy loam or silt loam subsoil in the second, third, and fourth feet. The first foot frequently consists mainly of white volcanic ash, or pumice, of a very fine sandy loam texture, which is sometimes mistaken for white alkali, but is very free from it, except in occasional low spots where water stands.

The worst alkali lands are plainly indicated by the growth of greasewood, where the quantity of alkali was found to range from 0.30 to 0.50 per cent. This greasewood land is found in the loam or silt loam soils between the north end of Butte Lake and Soda Lake in the east central part of the valley. It occurs in spots and strips among the sagebrush.

Analyses show the alkali to belong to the carbonate or black alkali type. The presence of the sulphates and chlorides, which are common forms of white alkali, is very limited. Common salt, sodium chloride, is very scarce and is not found in injurious quantities.

The remedy for injurious accumulations of alkali is efficient drainage, together with copious application of irrigation water to dissolve and wash out the alkali salts from the soil.

NATIVE VEGETATION AS A GUIDE IN SELECTING SOILS.

The native growth in the valley is an excellent guide in determining the various soils, their fertility, texture, depth, drainage, and alkali content. That portion of the valley covered with pine timber is usually underlain by sand or small gravel at 5 or 6 feet and is a deep porous soil with good underdrainage and usually free from marl. Other parts outside of the timber belt, covered with wild currant, incorrectly called "greasewood," consist of a well-drained sandy loam free from overflow. A heavy growth of sagebrush indicates a rich soil free from injurious amounts of alkali. Tule-grass (*Juncus*) indicates a swamp soil free from excessive amounts of alkali. Greasewood (*Sarcobatus vermiculatus*), however, shows that alkali is present, increasing in quantity with the size and quantity of greasewood. When greasewood is interspersed with rabbit brush the quantity of alkali is quite low and not prohibitive for ordinary crops. This native vegetation can guide the farmer in the direction of proper cropping. Thus, alfalfa grows best on level lands producing sagebrush, rabbit brush, or pine. Tule-grass (*Juncus*) land is too wet for it, and the pine land will need irrigation, while the remaining sandy

lands will need but little, if any, during normally wet years. Pine lands in the valley or lands covered with wild currant comprise the soils favorable for apples. The loams covered with sagebrush, rabbit brush, and similar growths are the soils favorable to sugar beets, grain, timothy, clover, and alfalfa, but not suitable for orchards.

IRRIGATION.

Irrigation has always been practiced to advantage in the valley since cultivation and cropping of the soils began. The sandy soils in the southern and the loam soils in the western parts of the valley, where small creeks and springs supplied water throughout the summer, were first irrigated. On account of the annual average rainfall dropping at times below 15 inches, irrigation will always be more or less necessary for securing heavy yields, especially with crops like alfalfa and sugar beets.

The whole valley floor is underlain by a water table at a depth varying from 1 to 10 feet. Over the main body of the level portion of the valley water is usually encountered from 4 to 6 feet from the surface. Crops of grain and alfalfa probably draw upon this supply directly. Other crops, such as potatoes, garden vegetables, or other cultivated crops, may secure a part of their moisture from this source when the soil is properly tilled.

This underground water is often under pressure, probably from the water which is lost at Butte Creek Sink. Such pressure is seen in the bubbling springs near Macdoel. As underground water is present over the whole valley at shallow depths, a great underground reservoir is always ready and available for pumping for the irrigation of crops. As the valley has no outlet, this supply will probably remain constant, varying with the annual rainfall.

QUALITY OF THE WATER OF THE VALLEY.

The waters in streams, springs, and wells, with the single exception of one spring at Mud Lake, were found to be quite pure and free from any injurious quantity of soluble salts. The springs contained on the average 20 parts of soluble matter per 100,000 parts of water, the surface wells from 10 to 40 parts per 100,000, and the streams from almost none to 10 parts per 100,000. These analyses show these waters to be quite pure and suitable for all domestic and irrigation purposes, especially the stream water, which is almost pure melted snow. In some of the alkali soils the wells contain considerably more alkali.

The water of Butte Lake, however, contains considerable quantities of alkali (120 parts of soluble salts per 100,000 parts of water), largely in the form of sodium carbonate, or black alkali. As a source

of irrigation water this lake is only available, therefore, for the better drained, loose sandy soils. Alkali Lake, situated in the east-central portion of the valley, is far too alkaline (305 parts of soluble salts per 100,000 parts of water) for either domestic or irrigation purposes. Mud Lake, a small pond covering about 40 acres in the low hills east of Macdoel, also contains very large quantities of alkali, and is unfit for either domestic or irrigation purposes. Cattle, however, drink these waters.

AGRICULTURAL CONDITIONS.

All the soils of the valley are well suited to grain crops, which have been grown to a limited extent for local demand for many years. Both heavy and sandy soils have produced good grain. The loams in the northern part of the valley at Picard and Sams Neck have been most extensively farmed.

Apple trees in the various small orchards in the valley have borne well, producing a fine, large, clear-skinned apple, free from all blemishes of insect and fungus pests and diseases. Every vegetable suited to the North Temperate Zone has been grown to surprising succulence and crispness. With these evidences and beginnings of agriculture before one, it is quite safe to predict the agricultural development of the valley.

Alfalfa, clover, and timothy will produce abundantly with little or no irrigation, according to the character of the soil and closeness of the ground water. Grains do well without water and will probably not need irrigation except in very dry years.

Sugar beets should prove a successful and profitable crop, and those grown experimentally have shown marked adaptation to the soil and climate. The level stretch of many thousands of acres, especially on the loam soils in the central and northern portions of the valley, when once cleared of sagebrush and other brushy growths, offer suitable soils for sugar beets. A promising crop for rotation with sugar beets is the Canada field pea, which will probably grow well in Butte Valley, for it has done very well in valleys of like altitude and climate in Colorado, as well as in several places in California. Great quantities of this seed are annually brought into California for use in growing this crop for green manuring purposes. The vine makes an excellent hay, especially for fattening young lambs for market. This industry alone has increased the value of the lands of the San Luis Valley in Colorado (a valley similar in many respects to Butte Valley) several fold. Canada peas and similar legume crops will enrich the soil and render it better fitted for sugar beets and grain crops.

Until such time as the tule-grass (*Juncus*) swamps can be drained and reclaimed for farming, they can be vastly improved for hay and pasturing purposes by sowing broadcast in the fall the seed of redtop

grass and velvet grass. These grasses make excellent feed and hay and will renew themselves by seed each year, thus permanently improving the swamp pastures where water does not stand too long or too deep.

Asparagus is another crop which will grow well if placed on the lower or more moist sandy loams. Some of the sandy loam tule-grass swamps if properly ditched and drained will undoubtedly produce excellent asparagus.

Hop soils are found in the sandy loam west of Macdoel, where the soil is loose and pliable and the ground water can be reached by the vine. The climate appears to be favorable to the production of a fine, bright hop. The poles necessary for the hop fields can be procured cheaply from the neighboring forests.

Potatoes grow well and should be a profitable crop on most of the soils in the valley where the soils are not too wet. When Butte Lake is drained the muck and loams now occupied by tules will produce excellent potatoes.

Garden vegetables have proven uniformly successful and excellent, especially cabbage, parsnips, turnips, beets, peas, and lettuce.

Apples will undoubtedly prove a valuable and extensively grown crop, for, except for occasional late spring frosts, the climate is ideal. Such small orchards as have been planted produce good crops of beautifully colored, clean, bright-skinned fruit. No pest affecting fruit or foliage has yet appeared, though caution should be exercised to prevent them from entering the valley.

In selecting apple soils great care should be exercised, for not all soils in the valley are suited to the culture of this fruit. The apple soils are found principally along the edges of coves of the valley, but they extend for a mile or two into the valley in the sandy loams where drainage is good and the water table 5 feet or more below the surface. The sandy loams in the valley floor suited for apples are readily found by the prevalence of the native growth of wild currant or even of pine. Sandy loams on the slopes along the eastern side of the valley, even when far above the ground water, will produce good apples. The dark-brown and reddish-brown loams along the western edge and slopes should also produce excellent apples. These loams vary considerably from the loams in the flat floor of the valley in their porosity and mellowness and their freedom from volcanic ash or any trace of alkali. This is due to better drainage and greater depth of water. In summing up, it may be definitely stated that the apple soils occur about the edges of the entire valley, where the ground water is considerably below the surface, on all the pine lands of the valley floor, and on those sandy loams growing considerable quantities of wild currant, the presence of this plant indicating a sufficient

depth of water table. Great care should be exercised in avoiding soils where the water rises above 4 or 5 feet of the surface, for the apple likes well-drained soils.

In extensive apple planting only three or four of the standard shipping and storing varieties well adapted to climates like Butte Valley should be selected. Among the foremost of these varieties may be mentioned the Spitzenberg, Newtown Pippin, Northern Spy, Jonathan, and Rome Beauty. Many other varieties which require full and bright color will do well, because a cloudless summer gives plenty of brightness and color to the fruit, but the main dependence should be placed on a few standard varieties.

Pears will grow on all soils suited to apples and perhaps also on wetter, heavier, and more alkaline soils. Cherries, however, need better drained, drier, and deeper soils than apples, with the water table at a good depth or a freedom from flooded condition at all times. The slopes of sandy loams about the valley are better suited to this fruit.

Plums, quinces, and berries, especially blackberries, raspberries, and currants, will also do well on the apple soil, and can be profitably grown between the rows of orchard trees during the years before the orchards come into bearing.

SOIL SURVEY OF THE BELLINGHAM AREA, WASHINGTON.

By A. W. MANGUM and LEWIS A. HURST.

DESCRIPTION OF THE AREA.

The area surveyed comprises 245,696 acres, or about 384 square miles, of the northwestern part of Whatcom County, Wash., which is the extreme northwestern county of the United States. It is confined within parallels $49^{\circ} 0' 2''$ and $48^{\circ} 45'$ north and meridians $122^{\circ} 49' 53''$ and $122^{\circ} 14' 33''$ west.

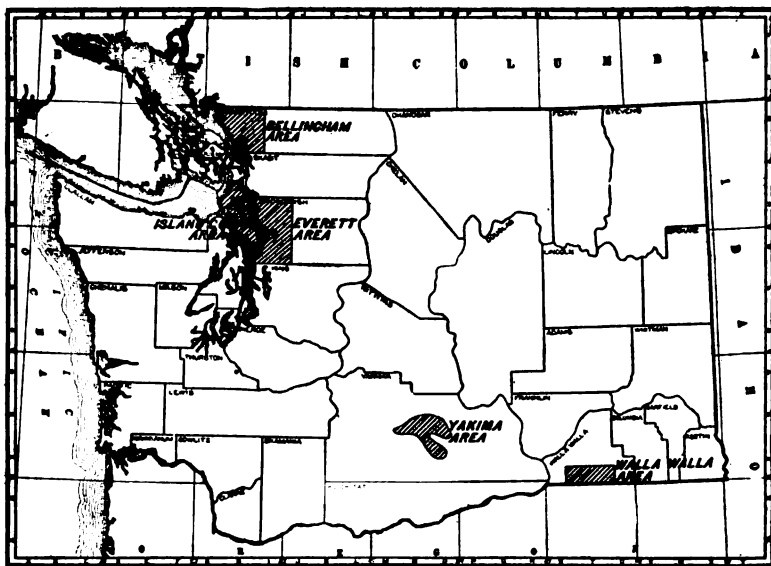


FIG. 36.—Sketch map showing location of the Bellingham area, Washington.

The area is bounded on the north by British Columbia, on the east by a north-and-south line passing about 1 mile east of Sumas, on the south by an east-and-west line through Bellingham, and on the west by the inlets and bays which form a part of Puget Sound.

The principal topographic features consist of the rolling uplands, which cover a large proportion of the entire district surveyed, the broad valleys of the Nooksack and Sumas rivers, the rough mountain-

ous region of the eastern and southeastern sections of the area, and the more or less extensive level areas, which represent the former basins of small lakes or shallow swampy depressions.

The upland consists of a series of ridges and rounded elevations, which vary in height from 50 to 300 feet above sea level. In many localities sharp rounded knolls, with intervening kettlelike depressions, occur, giving rise to the kame and kettle topography typical of glaciated regions. The hills and ridges are usually rounded and seldom steep enough to hinder cultivation. The valleys of the small streams draining the upland sections of the area are usually too narrow to permit the deposition of any alluvial material along their courses, and in many places where the topography is more hilly they occupy deep, canyonlike erosions, which have been cut down through the underlying glacial till to a depth of 40 to 75 feet. A large proportion of the central part of the area lies within a well-defined valley, which was probably formed by glacial action. The valley extends across the area from the eastern to the western boundary, but divides into two branches in the west-central part of the area, one of which follows a northwesterly course, reaching the Sound south of Blaine, while the other, which is occupied by the present channel of the Nooksack River, reaches the Sound at Bellingham Bay. Another branch of this valley crosses the northeastern part of the area and connects with the valley of the Fraser River a few miles beyond the limit of the survey.

The topography of this valley as a whole is gently rolling. The hills and ridges are low and rounded and slope gently toward the broad, shallow depressions, or comparatively level areas intervening. The streams which traverse this section of the area do not occupy deep, narrow channels, like those which traverse districts of a more rolling character, but flow through broad, comparatively level valleys, which are usually subject to overflow at times of high water.

The valleys of the Nooksack and Sumas rivers vary from 1 to about 3 miles in width. The surface is quite level, with a low ridge occurring often along the immediate borders of the stream, causing the land to have a gentle slope back from the present channels of the river. This sometimes results in the formation of small, poorly drained basins near the base of the more rolling area bordering the river valleys.

In the extreme northern part of the area there is an extensive plain or broad, shallow basin, locally known as the "Prairie." This region is almost entirely surrounded by rolling uplands and was formerly in a swampy, poorly drained condition. Other areas similar to this, but of much smaller extent, are found in many other sections of the area

surveyed. The surface of these shallow basins is almost level, but low, gentle swells, with broad, shallow depressions intervening, give them as a whole a very gently undulating topography.

The topography of the mountainous region is rough and broken. Some of the higher peaks rise to an elevation of 3,000 feet above sea level, and the intervening valleys are narrow and V-shaped. The hillsides are usually too steep for successful cultivation, and large areas of rock outcrop are frequently encountered on the more precipitous slopes.

The greater proportion of the area surveyed is drained by the Nooksack and Sumas rivers and their small tributaries. The Nooksack River enters the southeastern corner of the area and flows in a general northwesterly direction until it reaches the city of Lynden, in the north-central part, whence it turns in a general southwestward direction and empties into Puget Sound at Bellingham Bay. Its principal tributaries within the area are Fishtrap and Bertrand creeks, which drain a large portion of the northern section, and Anderson and Ten Mile creeks, which aid in the drainage of the southern and central sections.

The Sumas River rises in the foothills of the mountainous region near the eastern boundary of the area, and flows in a general northerly direction, passing out of the area at its extreme northeastern corner. It finally empties into the Fraser River, at a point some distance across the Canadian boundary line. The principal tributary is Johnson Creek, which joins the river near the city of Sumas. The Dakota and California creeks drain a considerable proportion of the northwestern part of the survey. These two streams rise in the west-central part, follow a general northwesterly course, and empty into Puget Sound at Drayton Harbor, just south of Blaine. There are many other smaller streams draining limited areas, which empty directly into Puget Sound or into Lake Whatcom.

The greater number of the earlier settlers were attracted to this area on account of the great timber resources of this section of the State, but as the forests have been gradually cleared away, the agricultural population has steadily increased. A large percentage of the present population came from the north-central and middle-western States, but many also came from New York and other States along the Atlantic seaboard. There are many, also, who have come from British Columbia and other sections of Canada. Quite a number of Hollanders have come in during comparatively recent years, settling in the north-central part of the area, and there are also many Scandinavian farmers.

The area as a whole is very sparsely settled and a large part of it is still covered by a heavy growth of timber or is in the partially.

cleared condition known as "logged off" land or "wild land." The "logged off" land is usually covered with a dense growth of underbrush and with the fallen trees, stumps, and "slashings" which remain after the merchantable timber has been removed.

The extensive level prairie north of Lynden is the most thickly settled part of the area, the reason being that this broad basin did not support a heavy growth of timber and could easily be cleared for agricultural purposes. In the rough, mountainous districts of the extreme eastern and southeastern parts of the area there are very few farms. The inhabitants of this region are mainly engaged in getting out the fir and cedar timber for the sawmills or shingle mills.

Bellingham, the county seat of Whatcom County, is the principal city within the area. It is located on Bellingham Bay in the extreme southern part of the area and has a population of about 30,000. Blaine, a town of about 3,000 inhabitants, is located on the coast of Puget Sound, in the extreme northwestern corner of the area. Sumas, another border town, with a population of about 1,200, is located on the Canadian boundary line in the extreme northeastern corner of the area. Lynden, Ferndale, Custer, and Everson, which are situated in the valley of the Nooksack River, are towns of 500 to 1,400 inhabitants.

The transportation facilities furnished by the railroads and steamship lines are exceptionally good. A division of the Great Northern Railway System, which extends from Seattle to Vancouver, British Columbia, traverses the western part of the area, passing through Bellingham, Ferndale, Custer, and Blaine. The Seattle, Everett and Vancouver division of the Northern Pacific Railroad passes through the eastern part of the area, connecting with the Canadian Railroad at Sumas. The Bellingham Bay and British Columbia Railroad traverses the area from Bellingham to Sumas, and a spur of this line extends from Hampton to Lynden. Stage lines, carrying both passengers and freight, make two trips daily between Bellingham and Lynden and Bellingham and Ferndale. The southeastern part of the area is traversed by another stage line, connecting Bellingham with Deming, which is located just east of the area surveyed. Steamships run regularly between Bellingham and all of the larger cities on Puget Sound, including those in both the United States and Canada. The harbor at Blaine also makes that town a shipping point of considerable importance.

Bellingham is the principal local market for all the products of the area. The surplus products are shipped to Seattle, which offers a ready market for all kinds of farm produce. The dairy products not sold at the local markets are handled by the creameries which have been established in almost all of the more important towns of the area. A large part of the output of the creameries goes to Seattle and

other larger outside markets. The surplus fruit was formerly marketed at Seattle, but the Fruit Growers' Association of Whatcom County has recently made arrangements to ship directly to the larger markets of the Middle Western States. There is usually a demand at the local markets for all the hay and grain produced in the area.

CLIMATE.

The nearness of the Japan Current, which here impinges upon the coast, and the sheltering influence of the lofty Cascade Range bordering the eastern edge of the area have so reduced the extremes in temperature for summer and winter as to give this region one of the most equable climates in the United States. The records of the Weather Bureau for the last nine years (1898 to 1906 inclusive), kept in Bellingham, show that the nine hottest days in that period had an average temperature of 85° F., while the nine coldest days averaged 12° F. above zero. The mean annual temperature for the same period was 50.2° F. The summers are characterized by cool nights and invigorating sea breezes during the day.

The atmosphere is decidedly humid, yet the mean annual precipitation is rarely more than 32 inches. The rain falls in gentle showers or precipitates in the form of fog or mist. The average annual snow-fall ranges only from 0 to 10 inches and snow usually melts within a few hours. The greater part of the precipitation occurs during the period November to April, which is locally called the "rainy season." The greatest monthly precipitation is usually less than 6 inches. The records show that on an average 250 days of the year have neither rain nor snow.

The general effect of such climatic conditions is to produce a profuse growth of both native vegetation and cultivated crops. Oats give heavy yields, and timothy sometimes grows to a height of 7 feet with heads 7 to 12 inches long. The native vegetation is practically impenetrable, owing to its prodigious growth. The native forest trees are frequently from 5 to 15 feet in diameter and 150 to 200 feet in height. The climate is especially favorable to the growing of potatoes, small fruits, vegetables, apples, pears, plums, prunes, etc.

The equable climate, the distribution of rainfall, and absence of storms of any kind insure the farmers against annual crop failure, although the yields necessarily vary with the seasons. The growing season is long enough to harvest those crops for which the soils of this area are particularly adapted. The mild winters make it possible to pasture stock for the entire year and shelter is only necessary for a very limited time.

The following table gives the mean annual and maximum and minimum temperatures and precipitation, and condition of sky from 1898 to 1906, inclusive:

Year.	Length of record (years).	Temperature, ° F.				Precipitation (inches).				Sky.				Prevailing direction of wind.
		Annual mean.	Highest.	Date.	Lowest above zero.	Total for year.	Greatest monthly.	Month.	Total snow (inches).	Number rainy days.	Number clear days.	Number partly cloudy days.	Number cloudy days.	
1898..	4	50.0	84	Aug. 1	18	Jan. 25	28.40	4.08	Nov ..	6.0	133	143	125	97 SW.
1899..	5	49.7	96	July 28	3	Jan. 4	33.29	5.74	Nov ..	24.0	131	99	134	132 SE.
1900..	6	50.7	78	July 30	12	Nov. 21	34.73	4.40	Dec...	7.0	139	145	102	118 SE.
1901..	7	49.9	80	June 18	9	Jan. 9	31.99	5.91	Nov ..	15.3	120	133	137	96 SW.
1902..	8	49.9	94	Aug. 9	10	Jan. 25	31.27	5.98	Nov ..	9.3	113	123	143	99 SW.
1903..	9	49.5	86	June 8	19	Mar. 12	32.63	5.47	Nov ..	10.0	108	137	143	85 SW.
1904..	10	50.0	82	July 21	15	Feb. 9	29.88	5.75	Nov ..	13.5	87	154	102	110 SW.
1905..	11	50.3	81	Aug. 7	13	Feb. 10	27.59	6.82	Sept ..	0.0	87	167	121	77 W.
1906..	12	51.6	83	July 14	15	Mar. 15	33.72	5.43	Dec...	4.5	95	161	107	97 W.

Normal monthly and annual temperature and precipitation.

Month.	Bellingham.		Month.	Bellingham.	
	Temper-ature.	Precipi-tation.		Temper-ature.	Precipi-tation.
	°F.	Inches.		°F.	Inches.
January	39.4	3.17	August	60.9	1.11
February	42.3	3.10	September	55.9	1.96
March	44.1	2.61	October	51.0	2.16
April	48.6	2.61	November	43.9	5.00
May	53.6	2.57	December	42.2	4.61
June	58.2	2.15	Year	50.0	31.98
July	60.2	.88			

At Bellingham in 1906 the date of the last killing frost in spring was April 12, and of the first in fall October 20.

AGRICULTURE.

The area surveyed was first settled in 1852, but the population increased very slowly until about 1880, when the development of the great timber resources of the county began to attract settlers from the eastern States and from the older settled districts of the Northwest. After the advent of the railroads, about 1890, the development was more rapid, and large areas in the Nooksack and Sumas river valleys and Lynden Prairie, as well as smaller "logged off" areas on the uplands, were soon put under cultivation in order to supply the demand for farm produce created by the large lumber camps and rapidly growing towns which sprung up as a result of the lumber industry.

The valleys of the Nooksack and Sumas rivers and the broad, level prairie north of Lynden were first put under cultivation, and these sections of the area are at present more highly developed agriculturally than the rolling uplands. This is due to the fact that the river valleys did not support such a heavy growth of timber and could be cleared and put under cultivation at a comparatively small cost, and that the deep accumulations of organic matter and low, bushy growth, which covered the extensive poorly drained basin, known as "the prairie," could be easily burned off as soon as the land was thoroughly drained.

The difficulty of clearing the land of the stumps, fallen trees, and slashings, after the merchantable timber is removed, has greatly retarded agricultural development in the uplands, and the greater part is still in the condition locally known as "wild land." The old method of removing the stumps was quite expensive, and in many sections the cost of clearing land once covered by a heavy growth of timber averaged \$80 to \$150 an acre; but the more improved method now coming into general use, which consists of blowing up the stumps with powder or dynamite and pulling out the fragments by means of a donkey engine and wire cable, has reduced the cost of clearing land about one-half. When these uplands are once cleared and put under cultivation they are very productive, and farming has proved to be very profitable, even where the older and more expensive methods of clearing were used.

Lumbering is still the principal industry, and agriculture is at present only in the first stages of its development, but it is steadily growing in importance, and the area is rapidly becoming an agricultural section. The first crops grown were oats, hay, and potatoes, and these continue to be the staple products. During recent years, however, fruit growing has become one of the important industries, and the acreage planted in orchards is annually increasing.

Oats, hay, and Canadian field peas are principally grown in the river valleys or in the broad level areas which were once in a poorly drained condition. The better drained soils, both in the river valleys and small prairies, are well adapted to fruit, small fruits, and vegetables, and they often produce yields equal to those obtained in any other section of the area, but the comparatively small cost of clearing the lands has resulted in extensive methods of farming and has enabled the farmers in these localities to cultivate profitably such crops as oats, peas, and hay. In the uplands the farming is more intensive, with the principal crops fruits, small fruits, and Irish potatoes. Clover, timothy, and grain do exceedingly well on the upland soils; but as no large areas in the uplands have yet been cleared, the land is now devoted to those crops which are better adapted to intensive farming and give larger returns from a limited acreage.

The Canadian field pea is grown in many parts of the area. The crop is thrashed and yields about 40 to 50 bushels an acre. It is used mainly as feed for hogs, though a part of the crop is sold at the local markets for a good price.

The oats grown in the area are of excellent quality, and the large yield secured, together with the high prices obtained at the local markets, has made this a very profitable crop. On the soils best adapted to this crop 70 to 100 bushels are secured, though a yield of 125 bushels an acre is reported. Wheat also does well on many types of soil, but the climatic conditions are not favorable to the varieties thus far introduced in the area, the kernel being too soft for milling purposes. The small quantity of wheat produced is used mainly for chicken feed. Barley has been grown on a limited acreage, producing about 40 bushels an acre. A local brewery furnishes a ready market for this crop.

The Irish potato is one of the most important products of the area. The yields obtained range from 150 to 400 bushels an acre, and there is a fine local market for the crop at good prices. The potatoes grown are dry, mealy, and of good keeping quality and size. The principal varieties are the Early Rose, Late Rose, Burbank, Beauty of Hebron, and Champion of the World.

Clover and timothy do well on many types of soil, and from two to three cuttings can be obtained annually. Owing to the comparatively short season suitable for curing the hay, only one crop is cut, the land being used during the remainder of the time as pasture. The average yield of hay is about 3 tons an acre, and with the exception of that grown on the low, marshy areas, which usually contains a large amount of coarse native grasses, it is of good quality and brings high prices in the local market. The better quality of hay brought locally as much as \$20 a ton during the season of 1907. A small acreage is in corn, but the varieties grown so far do not seem adapted to the climatic conditions and do not mature.

The principal varieties of apples now successfully grown for shipment to the larger markets are the King, Wagner, Gravenstein, Rhode Island Greening, Baldwin, Maiden Blush, Dutch Mignon, Wolf River (large), Gloria Mignon, and Alexander. The quality of this fruit is excellent. The King, Wagner, and Gravenstein are the favorite varieties, and seem to be well adapted to the soil and climatic conditions. Several varieties of cherries are grown, and the yields obtained are very good in quality and quantity. The Black Republican and Queen Anne seem to give the best results. Pears also do exceedingly well on many of the soil types, and very large yields are always obtained. The varieties which seem best adapted to the soils and climatic conditions are the Bartlett, Clapp's Favorite, Bennett, Clairegeau, Anjou, and Kieffer.

Some orchards of fall apples and pears have been set with local seedlings, but the best results have been obtained with trees from nurseries located in the State or in Oregon, where the climatic conditions are very similar to those found in this area. A few varieties have been introduced from abroad but with small success.

Both prunes and plums give large yields, but up to the present time there has been a poor market for these products. During the present season (1907), however, several shipments of prunes have been sent to the larger markets and have brought very fair prices. The Italian, Hungarian, Golden Drop, and Silver are the favorite varieties and all of these thrive. The Italian is the most popular.

Grapes are grown to a very limited extent. Very fair yields are secured. The varieties giving the best results are the Champion, Concord, and Niagara.

Vegetables, such as cabbage, carrots, squash, turnips, asparagus, sugar beets, garden peas, pumpkins, and cauliflower, are produced for the local markets. Celery of very fine quality is grown on some of the heavier organic soils, and rhubarb also does exceedingly well. Small fruits—blackberries, raspberries, and strawberries—are as yet grown on a very limited scale, though the large yields and the good prices obtained are causing a rapid increase in the acreage. The Snyder and Lawton blackberries and the Cuthbert raspberry are of fine quality and at present the most popular varieties. Strawberries produce from 200 to 300 crates of 24 quarts each per acre and are disposed of locally at good prices.

The growing of flower bulbs has been carried on in the area for several years, under the supervision of the United States Department of Agriculture. The limited acreage under cultivation thus far has demonstrated that both the soil and climatic conditions are well adapted to this industry, and that tulip, hyacinth, lillium candidum, and crocus bulbs, etc., equal to those imported from Holland, can be grown.

Dairying is one of the principal as well as one of the most profitable industries in the area. On account of the mild climate there is little need of warm shelter for the stock and there is an abundance of pasturage during the entire year. The dairy products of the area rank high in quality and the herds of improved breeds of dairy cattle are annually increasing.

The raising of poultry is also becoming an industry of considerable importance, and some of the rougher land near the larger local markets which is not well adapted to agricultural purposes is now being utilized for poultry farms.

The vigorous, healthy growth of all the agricultural products of the area, and the excellent results obtained from certain crops which have been grown from seed of local origin, seem to indicate that the

growing of seed to supply this and other areas of similar climatic and soil conditions, especially for such crops as cabbage, cauliflower, clover, timothy, and peas, would be profitable, and there is a possibility of this industry being developed. It is also probable that nurseries for the production of fruit trees will be established to supply the growing local demand.

The agricultural development of the area is of such recent origin that as yet little attention has been paid to adaptation of certain types of soil to certain crops. The areas of Lynden gravelly loam, which contain such a large percentage of gravel as to render them unsuited to crops requiring a frequent thorough cultivation, seem well adapted to fruit, and some of the finest orchards in the area are located on this type and on the Whatcom silt loam and Lynden silt loam. The well-drained areas of alluvial soil, the areas of Puget fine sandy loam, and of Puget silt loam always produce profitable yields of blackberries and raspberries. The larger yields of oats are obtained on the Puget clay, though the Puget silt loam is also well adapted to this crop. The Bellingham silt loam is well adapted to clover and timothy and is used chiefly for the production of hay. The Peat is the best type for celery, cabbage, and onions, but only a few very small areas are at present under cultivation. At present no well-established system of rotation is followed. In the river valleys, where the more extensive methods of farming are practiced, the usual rotation is oats, followed by timothy, and back to oats, but oats are frequently grown on the same fields for many consecutive years. Some rotation of crops is practiced on the small cultivated areas in the uplands, where potatoes, small fruits, and vegetables are the usual crops, but no regular system is followed. Where strawberries are grown, however, the plants give good yields for four or five seasons; the land is then cultivated to some other crop, usually potatoes or some other vegetable. The general tendency in the area is toward more intensive methods of farming, and the thorough cultivation of a small area to special crops is proving more profitable than general farming on a larger acreage.

The farm labor employed in the area is very efficient. The demand for laborers, however, by the lumber mills, logging camps, and other industries, at prices higher than can be obtained on the farms, has resulted in a scarcity of farm laborers, which is especially noticeable during the season of harvesting the hay and grain crops. The price paid for farm labor ranges from \$30 to \$40 with board, when hired by the month, and \$2 to \$3 when hired by the day.

The farms in the upland sections of the area seldom contain more than 40 acres, including the uncleared land, and the amount of land under cultivation on each farm ranges from 5 to 20 acres. In many sections of the uplands, and especially in the localities near the larger

markets, the land is being taken up in small tracts of 10 to 20 acres. In the river valleys and in the broad prairie north of Lynden the farms are larger and usually contain from 40 to 160 acres. As these lands are easily cleared, a large proportion of the farming land is now either under cultivation or is used as hay meadows and pastures.

The value of unimproved land in the uplands varies from \$10 to \$75 an acre, depending on location and on the character of the soil. Improved land in these sections varies from about \$75 to \$300 an acre, according to location and the extent of improvements. In the river valleys unimproved land brings from \$50 to \$100 an acre, while highly improved farms are valued at about \$200 an acre.

Intensive farming, a more thorough cultivation of the soil, the careful selection of seed, a more general use of barnyard manure on every type of soil, and the use of tile drainage on the soils occupying low, shallow depressions are suggested improvements in the agricultural practices of the area.

SOILS.

Sixteen types of soil, including Peat, Swamp, and Tidal swamp and marsh, were encountered in the area surveyed. Many of these soils owe their origin directly to the weathering of glacial deposits which cover the underlying rock to an average depth of several hundred feet, but in many localities the material forming the soil has been greatly modified by the action of the streams or by redeposition in the basins of small lakes or in poorly drained depressions. These various modifying agencies have played an important part in the formation of the different types.

The soils of the area have been separated broadly into five divisions: (1) Those derived directly from the weathering of the glacial deposits; (2) those derived from the recent alluvial deposits laid down in the valleys of the larger streams; (3) those derived from material which has been redeposited in the shallow basins of small lakes or swampy depressions; (4) soils occupying the rough mountainous region, and (5) the beach deposits formed by the action of the waves.

The entire area, with the exception of the higher mountain peaks, was covered in comparatively recent geological times by glacial ice, and as the ice melted the older geological formations were covered by great mounds of drift or by more or less stratified deposits of silt, sand, and gravel laid down by the water from the melting glacier in the form of glacial outwash. The glacial till, which forms the low, rounded hills and ridges of the upland sections of the area, weathers into the fine silty material which forms the surface soils of the upland types. Where the deeper deposits of till occur the soil is underlain

by a compact mass of silt, clay, and fine sand, containing only a small amount of gravel and small boulders. In some localities the finer material has been laid down as a shallow covering over coarser deposits of sand and gravel, which form a coarse, porous subsoil, such as underlies the surface soil of the Lynden silt loam.

This difference in the texture of the deeper subsoil makes a decided difference in the agricultural value of the two principal upland types.

The deep deposits of stratified sand or gravel found in the old glacial valley, which extends across the central part of the area, were probably laid down by water during the period when this valley served as an outlet for the water from the melting ice. The two light sandy loam soils which occur in this section are derived from these sandy deposits. The Lynden sandy loam, which has the coarser texture of the two, occupies the low sandy ridges and gently rolling terraces which extend across the north-central part of the area in the same general direction as the valley. The small areas of Lynden fine sandy loam, however, usually occur near the outer edge of the glacial valley, where the deposits laid down by the water contain a larger percentage of fine sand and silt.

The stratified gravel deposits, which occur more or less extensively in many sections of the area, forming the soil mapped as Lynden gravelly loam, represent the coarser materials deposited as glacial outwash by the waters of the melting ice.

The recent alluvial deposits in the valleys of the Nooksack and Sumas rivers consist of fine sand, silt, and clay. At times of overflow the coarser material held in suspension is deposited in the swifter currents near the present channels of the streams, forming the low sandy ridges adjacent to the river courses which give rise to the Puget fine sandy loam.

The broad valleys of both the Nooksack and Sumas rivers were formerly covered by a deposit of sand, but over a large proportion of these valleys the sand has been covered by more recent sediments of silt and clay laid down during times of overflow. In the shallow depressions, where water has collected and stood for long periods, the silt deposits are often many feet in thickness and give rise to the heavier alluvial soil mapped as Puget clay. Over the greater proportion of these valleys, however, the silt deposits have an average thickness of only about 20 to 30 inches, overlying the fine sandy subsoil, forming the soil which has been classed as Puget silt loam. Many more or less extensive deposits of partially decomposed organic matter occur in both the old glacial valley and in the more rolling sections of the area. These accumulations of Peat often cover the underlying soil to a depth of 10 feet or more. They are the result of the slow decomposition of large accumulations of vegetable matter in areas where the natural drainage is insufficient.

Many small, shallow basins or broad, poorly drained depressions occur in various sections of the area. Some of these represent the former basins of small lakes or ponds, while others are simply large depressions almost completely surrounded by rolling uplands, such as are frequently found in glaciated areas. The small lake basins have been gradually filled up by material washed into them from the surrounding uplands, and the soils usually consist of heavy silty loam containing a large amount of organic matter. The heavier type of soil found in these areas has been mapped as Bellingham silt loam.

In the larger basins, such as that occupied by the Custer silt loam, the finer particles of silt and clay, held in suspension by the water which formerly covered the areas, were gradually laid down over the coarser sandy deposits of an earlier period. The silty material covers the underlying sand to an average depth of 20 to 30 inches. A large proportion of the areas occupied by both the Custer silt loam and Custer loam was formerly covered by deposits of organic matter, but this has either been burned off recently or during some great forest fire in the past.

The smaller basins occupied by the Custer loam usually occur adjacent to areas of the light sandy soils, and the material which has been washed down and redeposited in these poorly drained areas contains a higher percentage of sand than that which forms the Custer silt loam. The subsoils of the two types are very similar in texture, and the sand underlying both types is often cemented into a compact mass by iron, the content of which is high. The larger areas of this character occur in the Custer loam, although there are no large deposits of bog iron, such as are found in the area occupied by the Custer silt loam.

The soil occupying the mountainous part of the area mapped as Whatcom stony loam contains a large amount of rock fragments and small bowlders and, as a whole, is of low agricultural value. This soil is principally derived from the weathering of glacial drift, but areas of rock outcrop frequently occur on the steeper slopes, and the material formed from the disintegration of the underlying rocks has also entered into the formation of the soil, especially along the slopes of the higher elevations.

The beach deposits are of small extent and of little or no agricultural value. They consist of coarse sand and gravel, which have been laid down along the shores of small inlets and bays by the action of the waves.

When properly cultivated the soils of the area are very productive and produce profitable yields of all crops adapted to the climate. The Whatcom stony loam is similar in texture, topography, and agricultural value to the rough, mountainous land mapped as Miami stony

loam in the Everett area, Washington. The Puget silt loam is also similar to the soil found in the Snohomish and Stilaguamish valleys. The Coastal beaches have many of the characteristics of the Galveston coarse sand of the Everett and Island County areas, but contain a higher percentage of rounded waterworn gravel.

The following table gives the name and extent of each soil type found in the area:

Areas of different soils.

Soil.	Acres.	Percent.	Soil.	Acres.	Percent.
Whatcom silt loam.....	62,592	25.6	Custer silt loam.....	8,960	3.6
Lynden sandy loam.....	30,208	12.4	Custer loam.....	8,128	3.3
Whatcom stony loam.....	28,608	11.6	Puget clay.....	7,424	3.0
Lynden gravelly loam.....	16,640	6.8	Lynden fine sandy loam.....	5,696	2.3
Peat.....	16,640	6.8	Swamp.....	2,816	1.1
Lynden silt loam.....	16,256	6.6	Coastal beaches.....	832	.3
Puget fine sandy loam.....	13,888	5.7	Tidal swamp and marsh.....	820	.1
Puget silt loam.....	13,632	5.5	Total.....	245,696	.....
Bellingham silt loam.....	13,066	5.3			

WHATCOM SILT LOAM.

The soil of the Whatcom silt loam consists of a light-brown to reddish-brown silt loam, with an average depth of 15 inches, containing a considerable quantity of organic matter. A few fine gravel or small iron concretions are frequently found in the soil, but as a whole it has a fine silty texture.

The subsoil consists of a heavy loam or silty loam of a light drab to gray color, which contains an appreciable quantity of coarse material, but also enough silt and clay to make it sticky and plastic when wet and to give it a compact, massive structure. A little gravel is often found in the upper part of the subsoil, but the quantity of this material usually decreases with depth, and the lower part of a 3-foot section is a dry, compact, heavy loam which contains a high percentage of silt and clay. A few small glacial boulders are occasionally found scattered over the surface or embedded in the soil or subsoil.

The largest unbroken area of the Whatcom silt loam occupies the uplands in the southern part of the survey, but other extensive areas occur in almost every section of the area surveyed. The surface is distinctly rolling, with low, rounded hills and slopes seldom steep enough to cause erosion. Many shallow depressions almost completely surrounded by the low hills and ridges occur and in some localities small knolls of glacial drift with intervening poorly drained kettlelike depressions. The finer material washed down from the higher areas is redeposited in these depressions, giving rise to small areas of the Bellingham silt loam, and where of sufficient extent they have been indicated on the soil map, but many areas only a few

square rods in extent are found scattered over every large area of the Whatcom silt loam, and these could not be shown. With the exception of such small depressions the soil is well drained.

The Whatcom silt loam supports a heavy growth of fir, cedar, and hemlock timber, and it is often very difficult to remove the stumps and windfalls, even after the land has been cleared of merchantable timber. The soil is very productive, breaks up into a fine loamy condition, giving a splendid seed bed, and is easily kept in good cultivation. No large areas have been cleared, and the farms are small, the cultivated area seldom exceeding 20 acres. The small acreage of this soil now under the plow is proving very profitable, and the extent of cleared land is steadily increasing.

The soil seems well adapted to strawberries, Irish potatoes, vegetables, and to such fruits as apples, pears, plums, prunes, and cherries.

The small acreage seeded to clover and timothy has demonstrated that these crops, especially clover, do exceedingly well. The yield of hay averages from 3 to 4 tons per acre. Oats and barley produce very fair yields, but owing to the fact that such a small acreage of each farm is under cultivation the land is usually used for crops better suited to intensive farming. Peas, cabbage, and other garden truck are grown for the local markets and profitable yields are secured.

Strawberries yield from 200 to 300 crates of 24 quarts each per acre, and when properly cultivated the plants will continue to bear for five seasons. Hill cultivation apparently gives the best results. Blackberries and raspberries also do well. Irish potatoes yield an average of 8 to 10 tons per acre, and the product obtained is of very fine quality.

The small orchards located on this soil produce large yields and are in a very flourishing condition, although little attention is given to spraying.

The uncleared areas of the Whatcom silt loam are valued at \$20 to \$100 an acre, according to location; the cultivated land at \$100 to \$300 an acre, and highly improved land near the larger markets, from \$500 to \$700 an acre.

The following table gives the results of mechanical analyses of a sample of the soil, subsoil, and lower subsoil of the Whatcom silt loam:

Mechanical analyses of Whatcom silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16976.....	Soil	0.7	5.4	3.3	10.7	6.4	63.1	9.5
16977.....	Subsoil.....	1.4	5.8	4.5	16.4	9.4	49.6	13.1
16978.....	Lower subsoil..	1.5	5.4	4.1	15.6	10.3	48.5	14.7

LYNDEN SILT LOAM.

The soil of the Lynden silt loam to an average depth of 15 or 20 inches consists of a light-brown, silty, very fine sandy loam, containing a considerable quantity of organic matter. Some fine gravel and coarse sand particles are usually present in the soil, but not in sufficient quantities to have a marked influence on its texture. The subsoil consists of a compact mass of gravel and sand. The sand content varies in texture from fine to coarse, the coarser grades predominating, while the gravel is rounded and varies in size from fine particles to cobbles several inches in diameter.

The largest area of this soil occurs in the western part of the survey, occupying the greater proportion of the rolling uplands bordering the coast between Birch Bay and Lummi Bay. Another extensive area is found in the northwestern part of the survey, while smaller bodies appear in various other sections of the uplands.

The topography as a whole is rolling, but the hills are low and rounded, sloping gently toward the intervening valleys. Large, gently undulating or comparatively level areas occur at frequent intervals. The topographic features, together with the porous character of the subsoil, insure good natural drainage and in some places the type is too thoroughly drained for the best results with the crops grown.

The soil is derived from the weathering of glacial sediments of fine sand and silt, which were laid down over coarse glacial deposits of sand and gravel. It supports a very heavy growth of fir, cedar, and hemlock, and it is very difficult to clear the land for farming purposes. Only a limited acreage is under cultivation.

The Lynden silt loam is well adapted to fruit growing, and some of the best orchards in the area are located on it. Very large yields of apples, pears, plums, prunes, and cherries are obtained, and the fruit is of fine quality. Small fruits, such as raspberries and blackberries, are grown to a limited extent and do well, especially during a wet season, but the average yields to the acre are not so large as those obtained on the alluvial soils of the river valleys. Strawberries, however, do exceedingly well, and the yields often equal those obtained on any other soil in the area. Clover and timothy are grown to a limited extent, and while the yields are not as large as on some of the soils that have a heavier subsoil, a very fine quality of hay is produced. Clover seems better adapted to this soil than timothy, and usually gives better results. This land produces a fine quality of Irish potatoes, the yields averaging 200 bushels an acre. When well cultivated and heavily manured, much larger yields have been secured. Vegetables do well, especially in a wet season. These crops, however, sometimes suffer during a dry season, owing to excessive drainage, the result of the porous character of the subsoil.

The cultivated areas of the Lynden silt loam are valued at \$100 and \$200 an acre, according to the extent of the improvements. The uncleared lands range in value from \$35 to \$75 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Lynden silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17705	Soil.....	6.0	8.4	1.0	1.6	19.1	58.8	9.8
17706	Subsoil	19.8	43.6	6.0	6.9	4.0	14.7	4.6

LYNDEN SANDY LOAM.

The Lynden sandy loam to an average depth of 12 to 15 inches is a gray to light-brown sandy loam, underlain by gray, loamy sand of a more or less stratified structure, which often contains an appreciable amount of coarse sand and fine gravel. The sand content of this soil frequently varies in texture within areas of very limited extent, as, for instance, along some of the gentle slopes where the surface has become slightly eroded, and a small amount of the coarser material composing the subsoil has become mixed with the soil, giving it a slightly coarser texture than that which occupies the more level areas. The areas bordering the present valleys of the rivers also contain a higher percentage of coarse sand particles than those found along the outer edge of the old glacial valley, where the soil grades into types of a more silty texture or into areas of the Lynden fine sandy loam.

These slight variations in texture, however, are not great enough to affect the agricultural value of the type as a whole, and the areas of finer or coarser texture occur so frequently within such small areas that it was found impracticable to attempt their separation in a map of the scale used.

The sandy deposit which forms the subsoil usually becomes coarser in texture as the depth increases, but small pockets of a finer textured sand or of fine gravel are often encountered.

The Lynden sandy loam occurs in more or less extensive bodies in almost every part of the broad glacial valley which traverses the central part of the area from its eastern to western boundary. The main bodies of the type, however, extend across the central and west-central sections of the area, following very closely the general direction of the main branches of the broad valley. The topography is gently rolling. The ridges and knolls are low and rounded and slope gently toward the broad, comparatively level areas intervening.

The soil has suffered very little from erosion except in a few limited areas on the steeper slopes bordering the present river valleys or some of the smaller stream courses.

The character of the surface, together with the sandy texture of the soil and subsoil, insures good natural drainage, causing the soil to warm up early in the spring and enabling the farmer to cultivate the land immediately after the spring rains.

The deposits of sand which form the subsoil of this type were probably laid down by floods during the period when the valley served as an outlet for the waters from the melting glacier. No large boulders occur, and the stratified structure seen in some of the deeper cuts indicates deposition by water.

Up to the present time only a small area of the Lynden sandy loam has been cleared and put under cultivation. The greater proportion of it is still covered by a heavy growth of timber or by the stumps, windfalls, or underbrush left by the lumberman. When properly cultivated the soil produces very profitable yields of potatoes, fruits, and small fruits. Both clover and timothy have been grown on a limited acreage with good success. The yields are not as large as those obtained on some of the soils of heavier texture, though the hay is of fine quality. This soil seems well adapted to the growing of early vegetables and large yields are always secured. Field peas and garden peas do well, the former often producing from 50 to 60 bushels per acre. The small orchards located on this type are in a very flourishing condition and produce large yields of apples, pears, plums, prunes, and cherries.

The "logged off" areas of this land are valued at \$30 to \$50 an acre. The cleared land is worth from \$75 to \$300 an acre, according to the location and improvements.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of the Lynden sandy loam:

Mechanical analyses of Lynden sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17044, 17046, 17707.	Soil	4.7	31.6	15.7	11.1	1.1	28.7	7.1
17045, 17047, 17708.	Subsoil.....	2.9	40.8	23.4	20.0	1.6	8.0	3.4

LYNDEN FINE SANDY LOAM.

The soil of the Lynden fine sandy loam is a light-brown to reddish-brown, fine sandy loam, having an average depth of 15 to 20 inches, and containing enough silt and clay to give it a very fine loamy tex-

ture. The subsoil consists of a very light-brown to gray, fine sandy loam, which usually contains a large amount of silt in the upper 12 to 15 inches, but gradually becomes lighter in texture as the depth increases, grading at about 30 inches into a fine loamy sand.

The lower part of the 3-foot section is usually quite sandy, and the greater proportion of the whole type is underlain at a depth of 3 to 5 feet by a compact loamy sand, which is slightly coarser in texture than the upper subsoil. Small pockets of fine gravel sometimes occur in the deeper subsoil, but these are of rare occurrence and are seldom more than a few square rods in extent. The soil, on account of its fine loamy texture, is easily reduced to a state of thorough cultivation.

The largest area of the Lynden fine sandy loam occurs in the west-central part of the survey, a few miles southeast of the town of Fern-
dale, and another area of considerable size is found in the north-western corner. Several other smaller bodies of this type are encountered in the western and west-central sections of the survey. This soil usually occurs along the outer border of the old glacial valley and adjacent to areas occupied by soils of a heavier silty texture. The greater proportion of each of the several areas occupied by this type is comparatively level, but the low ridges, gentle swells, and low, rounded knolls give the type as a whole a very gently undulating topography. The soil in the more level areas contains the larger quantity of silt, and this, together with the large content of organic matter, often causes the surface to have many of the characteristics of a light silty loam. On the other hand, that occupying the low knolls and ridges frequently contains a higher percentage of fine sand and is slightly lighter in texture than the greater proportion of the type. The soil has good natural drainage. It is not subject to damaging erosion.

The Lynden fine sandy loam is derived from the finer sediments of sand and silt deposited by flood waters during the period of ice invasion. It supports a heavy forest of fir and cedar and a dense undergrowth of ferns and other native vegetation. Only a very small proportion of the type has been cleared and put under cultivation. It produces very fair yields of all crops grown. Oats yield on the average 60 bushels an acre and Irish potatoes about 200 bushels, though when thoroughly cultivated and heavily manured much larger yields have been secured. Clover and timothy have been successfully grown on a limited acreage and produced about 3 tons of hay an acre. Cabbage, cauliflower, carrots, pumpkins, garden peas, cucumbers, and other vegetables do well. Canadian field peas yield from 50 to 60 bushels an acre. Many small orchards of various kinds of fruit are located on this type and produce large yields.

The following table gives the results of mechanical analyses of the soil and subsoil of the Lynden fine sandy loam:

Mechanical analyses of Lynden fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
17733.....	Soil	0.1	5.7	7.8	29.5	11.5	35.9	9.1
17734.....	Subsoil.....	.0	3.1	6.7	29.7	23.6	28.9	8.2

CUSTER SILT LOAM.

The soil of the Custer silt loam, to an average depth of 15 to 20 inches, is a gray to light-drab silty loam, often slightly mottled with yellow iron stains. The soil contains a considerable quantity of organic matter, and in some small areas it is covered by a shallow deposit of peat or muck, varying in depth from 1 to 6 inches. The sand content increases with depth, and there is a slow gradation from the heavier silty soil into the lighter textured subsoil.

The subsoil consists of a compact loamy sand, which often contains pockets of small gravel and sometimes at lower depths pockets or thin strata of heavy silty clay. There is a larger proportion of silt and clay in the upper part of the subsoil, giving it a loamy texture and causing it to be sticky and plastic when wet, but the percentage of finer material rapidly decreases with depth, and the lower part of the 3-foot section is a compact loamy sand.

The subsoil contains a large quantity of iron, which often cements the sand particles into a hard, compact mass and causes a slight yellow mottling. Small iron concretions are found throughout the soil and subsoil and in some places large beds of bog-iron ore occur. Such deposits are not continuous or of large extent. Where they affect the agricultural value of the soil the areas have been indicated on the soil map by means of a symbol. The more important areas, where the gravel deposits already referred to influence the texture of the subsoil, have also been indicated on the map by means of a symbol.

The Custer silt loam is found in one large unbroken area in the northern part of the survey. It is known as "Lynden Prairie." Formerly the basin of a shallow lake, it has passed through the stages of a poorly drained marsh, with its dense covering of swamp vegetation and consequent deposit of peat or muck. When drained and cleared for agricultural purposes, the peaty surface soil was burned off over the greater proportion of the prairie, but an extensive deposit of organic matter is still found in the extreme northeastern corner. The surface is level to very gently rolling and the natural drainage is poor. Many large drainage ditches have been constructed, and a large part of the land is at present fairly well drained, although many

small bodies in the shallow depressions or more level areas still need more thorough drainage to fit them for agriculture.

The Custer silt loam is of lacustrine origin. The surface material, composed mainly of silt and clay, was laid down in the waters of a shallow lake. The coarser sandy material of the subsoil was laid down in the old lake basin at an earlier period, and the high organic content is the result of the drying up or filling of the lake and the growth and decay of rank swamp vegetation.

Owing to the fact that the land could be easily cleared and made ready for farming, the greater part of the Custer silt loam is under cultivation. For the same reasons the agriculture is more extensive than in the rolling upland sections, where the heavy timber growth has so far limited the areas under cultivation.

The principal crops are oats and hay. Oats yield on an average 50 to 60 bushels per acre, though a yield of 80 to 100 bushels has been secured on well-cultivated land in favorable seasons. Timothy and clover do well, producing 2 to 3 tons per acre, and even $3\frac{1}{2}$ to 4 tons is not uncommon. Canadian field peas are successfully grown, yielding 40 to 50 bushels an acre. Irish potatoes do well on the well-drained land, often yielding 300 to 400 bushels per acre. Where the land is thoroughly drained and well cultivated very good yields of cabbage, beets, peas, pumpkins, and other vegetables are obtained. Tree fruits and small fruits also give good results on the better-drained areas.

The improved farm land of this type of soil is valued at \$100 to \$200 an acre, depending upon location and drainage.

The following table gives the results of mechanical analyses of the soil and subsoil of the Custer silt loam:

Mechanical analyses of Custer silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17709	Soil.....	0.3	1.4	2.2	8.6	14.2	55.2	17.5
17710	Subsoil	.9	15.1	19.5	31.9	10.8	15.3	6.6

LYNDEN GRAVELLY LOAM.

The soil of the Lynden gravelly loam is a light-brown loam or silty loam, containing a large quantity of rounded, waterworn gravel. It has an average depth of 10 inches. The coarser material varies in size from coarse sand to small, rounded cobbles several inches in diameter, but is principally medium-size gravel. Gravel and a few small boulders are frequently scattered over the surface, the quantity varying considerably within small areas. In some places, especially along the slopes where erosion has been greater, such coarse material

often covers 60 per cent of the surface, while in adjoining areas the gravel occurs in beds covered with 2 to 4 inches of a brown loamy soil comparatively free from stones.

The subsoil consists of a more or less stratified mass of fine and coarse gravel and small, rounded cobbles. The interstitial material is composed of sand varying in texture from fine to coarse, with the latter predominating.

The stratified structure of these gravel deposits is often seen in the deeper cuts or gravel pits. The gravel beds frequently occur in layers from 2 to 10 feet thick, and are sometimes separated by thin strata of sand. Both the sand and gravel, however, occur in pockets or in compact masses, and there is little uniformity in the formation as a whole.

More or less extensive areas of the Lynden gravelly loam are found in almost every locality embraced by the survey. The two largest bodies are found in the northwestern section of the area. One occupies the gently rolling uplands along the Canadian boundary line, just east of Blaine, the other the greater part of the small peninsula projecting into Puget Sound just south of Blaine, between Drayton Harbor and Birch Bay. Other less extensive areas are found near the base of the range of mountains which crosses the eastern and southeastern parts of the survey, and in various sections of the old glacial valley. The topography is quite rolling, but many of the less extensive areas occupying broad terraces or low ridges are comparatively level or gently rolling.

The topographic position of this soil, together with the gravelly texture of the subsoil, insures rapid drainage, and, as a whole, the type is too thoroughly drained, and the crops, only limited acreages of which are grown, frequently suffer from the lack of moisture. The soil is derived from the coarser glacial deposits of sand and gravel, the structure of which, especially in the broad glacial valley, indicates that they were laid down by flood waters, probably as glacial outwash. The coarser material was later covered by a deposit of fine sand and silt, forming the present surface soil.

A very small percentage of the Lynden gravelly loam has been cleared, the greater part being still covered by a heavy growth of virgin forest or by the remnants of such forests left by the lumberman. The soil seems especially adapted to the growing of fruits, and much of the cleared land is used for their production. Apples, pears, plums, prunes, and cherries do exceedingly well, and the acreage devoted to orchards is annually increasing.

The gravelly nature of the soil and the difficulty of cultivating it properly render it poorly adapted to crops which require frequent turning of the soil. Very fair yields of Irish potatoes have been

secured on the areas having a comparatively small percentage of gravel in the surface soil.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of Lynden gravelly loam:

Mechanical analyses of Lynden gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17729	Soil.....	7.6	19.1	7.9	9.8	3.0	40.1	12.2
17730	Subsoil	16.7	43.9	14.1	15.1	1.9	3.6	4.0

WHATCOM STONY LOAM.

The soil of the Whatcom stony loam is a light silty loam or loam of a reddish-brown to light-brown color. The depth of the soil varies from 10 to 20 inches, with an average of 15 inches. The surface is usually strewn with gravel and small stones, while imbedded in the soil are numerous boulders varying in size from a few inches to several feet in diameter. The soil varies in depth and texture with its topographic position. On the lower ridges and bench lands or terraces it is usually a light silty loam with a depth of 15 to 20 inches, but on the steeper slopes and mountain sides the soil is shallow, lighter colored, and contains a higher percentage of sand and gravel. In some places the soil has been entirely removed by erosion, exposing the subsoil, and frequently the underlying rock. Stones, gravel, and boulders occur more frequently on the mountain sides and steeper slopes than in the soil of the bench lands.

The subsoil is a heavy loam to silty loam of a light-gray color, containing usually a large quantity of gravel, small stones, and boulders. Where the underlying rock is several feet below the surface, the subsoil in the lower depths is a light-gray to bluish-gray silty clay, comparatively free from gravel. The underlying rock protrudes at irregular intervals throughout the type. The coarser material found in the soil and subsoil is derived from the underlying formation.

Where the Whatcom stony loam occupies the lower hills and bench lands it can be profitably cleared and put under cultivation, since the rock outcrops, fragments of stone, and gravel are not so numerous as to interfere seriously with the tillage and handling of crops. The more precipitous slopes, however, could only be used for grazing, and will probably be more profitably kept in forest.

The largest body of this soil lies in the extreme southeastern corner of the survey and covers an area of about 20 square miles. The next largest body extends along the eastern boundary of the survey for a distance of 8 miles or more, and is a trifle less than 2 miles broad at its

widest point. It is about 11 square miles in extent. Another body containing from 9 to 10 square miles was encountered in the vicinity of Silverbeach. Kings Mountain and a small area near it were also included in this type.

The Whatcom stony loam occupies largely the lower ridges, bench lands, and foothills, which form a part of the extreme western range of mountains included in the Cascade Range. The topography is necessarily hilly to mountainous, with an elevation from 300 to more than 3,000 feet, the highest point being in the southeastern part of the area.

The drainage of this soil is rather excessive, and with a less humid climate crops grown on it would be seriously affected by drought. It frequently happens that the deposition of glacial material has so interfered with the natural drainage as to result in the formation of wet depressions, which are usually occupied by Peat. These areas can be drained readily by artificial outlets. The drainage of the bench lands or terraces is not so excessive as to impair their value for agriculture.

The Whatcom stony loam is both residual and glacial in its origin, as shown by the presence of rounded glacial boulders and fragments of rock in the soil and subsoil. The soil of the lower ridges and foothills is derived largely through the weathering of glacial drift, but on the steeper slopes and mountain sides the weathered material of the underlying rock formation has entered largely into its composition.

The native growth on this soil is fir, cedar, hemlock, and alder. It also has a heavy growth of ferns and underbrush. On account of its rough and broken topography very little effort has so far been made to remove the timber. The forest fires which occasionally pass over these sections, however, have destroyed much of the original growth. The timber, if properly handled, will always be a valuable asset.

A very limited acreage of the Whatcom stony loam is at present under cultivation. The rough, broken character of the larger part of this land limits the acreage suitable for cultivation. The value of the land for fruit growing is being demonstrated by those who have already taken up farms. It is particularly well adapted to the growing of apples, pears, plums, and other deciduous fruits, and it is claimed the fruit is less affected by late frosts in the spring on this soil than on many others in the area. Good yields of clover, timothy, and oats are obtained on the limited acreage cultivated to these crops. The raising of poultry and sheep would give good returns. Several small tracts in the vicinity of Silverbeach have been used for raising poultry and supplying eggs to the local market.

At the present time the value of this land depends largely upon the amount of standing timber, and its accessibility.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of the Whatcom stony loam:

Mechanical analyses of Whatcom stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17713	Soil.....	2.1	8.1	5.3	14.4	20.4	36.9	11.9
17714	Subsoil	3.5	8.2	6.6	17.6	19.7	34.0	9.7

BELLINGHAM SILT LOAM.

The soil of the Bellingham silt loam, to an average depth of 12 inches, is a dark-brown to drab-colored heavy silt loam, carrying a large quantity of decomposed organic matter. When turned up with a plow and in a dry condition, the soil becomes lighter in color and has a light-brown to gray appearance. The subsoil is a heavy, drab-colored to slightly mottled silt loam, which becomes somewhat heavier and more compact as the depth increases, and at 30 to 36 inches usually has the characteristics of a silty clay. Small pockets of gravel or coarse sand are frequently encountered in the deeper subsoil.

The Bellingham silt loam occurs in all parts of the survey, with the exception of those sections of the old glacial valley occupied mainly by a soil of a light sandy texture. It is found in small bodies, varying from a few square rods to about 1 square mile in extent. When properly cultivated the soil breaks up into a loamy, friable condition, but if plowed when wet, as in a poorly drained area, it has a tendency to clod, and it is difficult to reduce to a state of good tilth.

The soil occupies shallow depressions or small basins, which are almost completely surrounded by areas of more rolling topography. The smaller areas are found in the kettlelike depressions associated with the low knolls and ridges of the rolling uplands occupied by the Whatcom silt loam. Many of these depressions are not large enough to indicate on a map of the scale used, being only a few square rods in extent, but the soil is fairly typical of that found in the larger areas. The surface of the larger areas is comparatively level, but low mounds and gentle swells often give it, on the whole, a very gently undulating topography.

The Bellingham silt loam is naturally poorly drained. The shallow basins receive the drainage of the surrounding uplands and usually remain in a wet, partially flooded condition during the winter

months. The majority of these can be thoroughly drained without much difficulty. Tile drainage is practiced on a small scale and has greatly increased the agricultural value of the land.

The Bellingham silt loam is derived from material washed from the neighboring uplands. The structure as well as the general appearance of this material, especially that forming the deeper subsoil, seems to indicate that the material has been laid down in water during the periods when these basins were small ponds or lakes, or were in a wet, swampy condition. The large amount of humus in the soil owes its origin to the slow decomposition of the rank growth of vegetation which flourishes in such places.

This soil does not support a heavy growth of timber and is cleared with less difficulty and expense than the heavily forested uplands. The principal trees are cedar and alder, and the areas are known as alder bottoms.

A large proportion of the hay produced in this area is grown on the Bellingham silt loam, and it seems well suited to both timothy and clover. The yields range from 3 to 4 tons per acre. The poor natural drainage of the land has resulted in its general use as hay meadows, but when thoroughly drained, especially by tile, it produces very profitable yields of vegetables. Cabbage, cauliflower, peas, beets, and potatoes do exceedingly well. It is not as well adapted to fruit growing as the rolling uplands, although some kinds of small fruits give good results.

The value of this land varies from \$30 to \$200 an acre, according to its location, its condition as to drainage, and the extent to which it has been improved.

The following table gives the average results of mechanical analyses of the Bellingham silt loam:

Mechanical analyses of Bellingham silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17725, 17727	Soil.....	0.8	1.8	0.4	2.7	8.3	68.7	18.1
17726, 17728	Subsoil	.2	.7	.5	4.1	8.5	72.1	18.9

CUSTER LOAM.

The soil of the Custer loam is a gray to dark-brown loam, which has an average depth of about 10 to 12 inches. The upper part of the soil contains a large quantity of silt and the texture of the first 2 to 5 inches of the uncultivated land is often quite silty. The coarser material consists of various grades of sand, the proportion rapidly increasing with depth, as the sandy subsoil is approached. The Custer loam usually contains a large percentage of organic matter in

various stages of decomposition, the remains of the rank vegetation usually growing in moist situations. In some small areas the surface is covered by a shallow deposit of peat, seldom more than a few inches deep, while in others the organic matter is more thoroughly decomposed and has become intimately mixed with the fine silty surface soil.

The subsoil is a compact loamy sand, often containing pockets of fine gravel. The upper part usually carries a considerable quantity of silt derived from the soil, but the silt content rapidly decreases with depth, and the deeper subsoil has a very light sandy texture. The large quantity of iron present in the sandy subsoil often cements the sand particles into a hard, compact mass, and small beds of bog iron ore and pockets of iron concretions are frequently encountered at a depth of 1 to 3 feet below the surface.

The two largest areas of the Custer loam are found in the west-central part of the survey, one near Custer and the other near Enterprise. Smaller areas, however, occur in various parts of the old glacial valley. The soil occupies low, poorly drained depressions, which are usually partially surrounded by gently rolling uplands occupied by the Lynden sandy loam. The surface of these shallow basins is level or gently undulating.

A very small percentage of this type is under cultivation and this is usually in a poorly drained condition. It produces very fair yields of oats and hay, and when well cultivated the better drained areas produce good yields of potatoes and other vegetables. The average yield of clover is estimated at 2 to 3 tons and of oats about 40 to 50 bushels per acre. When this soil shall be thoroughly drained and well cultivated its agricultural value will be greatly increased.

The following table gives the results of mechanical analyses of the soil and subsoil of the Custer loam:

Mechanical analyses of Custer loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17701.....	Soil	4.7	32.8	10.5	8.3	5.4	29.3	8.8
17702.....	Subsoil.....	4.0	55.4	15.0	8.6	2.2	8.1	6.6

PUGET FINE SANDY LOAM.

The soil of the Puget fine sandy loam is a dark-gray to brown silty fine sandy loam. The silt content is greater where there is a slow gradation from the Puget fine sandy loam to the Puget silt loam and Puget clay or near the boundary line between these types. The average depth of the soil is 12 or 15 inches. Iron stains are some-

times encountered at various depths, but the dark color of the soil is due almost entirely to high organic matter content.

The subsoil is usually lighter, both in color and texture, than the soil, and iron stains like those found in the soil are more plentiful. The sand content is slightly coarser than in the soil, and the proportion of silt and other fine material is lower, except where an occasional thin layer of clay or sandy clay has been deposited with the sand. The subsoil is uniform to a depth of several feet.

The texture of both soil and subsoil is more or less variable along the smaller streams, but no attempt was made to separate these variations owing to the small areas over which they occur. The soil, being of a loose, incoherent structure, is easily cultivated, and even if plowed when moist breaks down into a light mellow loam. It is probably the easiest soil to till in the area.

The Puget fine sandy loam is confined almost entirely to the present valleys of the Nooksack and Sumas rivers, where it occurs immediately along the streams as a continuous body, varying in width from a few rods to a mile or more and having a very irregular boundary line. It occupies low ridges or comparatively level areas, which have a gentle slope away from the streams.

The loose, incoherent structure of both soil and subsoil permits of a free movement of the excess of soil moisture to lower depths, and on account of the slightly elevated position the excess of water falling upon the surface readily passes off into the natural drainage courses or into more depressed areas. The water table is usually several feet below the surface, insuring a warm, dry soil, except at times of high water. Some areas are still subject to overflows, which usually come at such seasons of the year as not to injure the crops to any appreciable extent.

The Puget fine sandy loam owes its origin to the deposition of material gathered up by the rivers in times of flood and laid down by the swifter currents during periods of overflow. The low, swamp-like basin near the mouth of the Nooksack River is rapidly being filled in by continued deposition of this sandy material.

The characteristic native growth is the willow. The land is easily cleared for cultivation, and hence a large proportion of it is now in farms, the percentage being greater than that of any other type in the area except the Custer silt loam.

This soil has been devoted almost exclusively to forage crops and pasture, with the exception of small areas in the vicinity of farm houses planted to orchards or small fruits and vegetables. Where the drainage is not impeded in any way, the soil is well adapted to fruits of all kinds, but more especially to raspberries and blackberries. The yield of red raspberries varies from 500 to 750 crates

per acre. When the soil is properly handled and careful attention is given to mulching and such methods of cultivation as will tend to conserve moisture there need be no fear of damage from drought. Large yields of potatoes may be obtained. The average crop is approximately 8 tons to the acre, although 10 tons have been harvested.

Where in close proximity to markets, the soil should be used more extensively for trucking. Timothy and clover are the leading forage crops, and yield from 2 to 3 tons of hay per acre. Oats produce heavy yields of grain of good quality.

The cultural methods practiced on this soil consist in breaking, harrowing, and seeding with the disk drill. Very little broadcasting is practiced. Seeding is usually done in the fall.

Land values vary with the character of improvements. The wild or unimproved land is held at \$40 to \$60 an acre and the improved farms at \$100 to \$200 an acre, and sometimes at a higher price, where accessible to markets.

The following table gives the results of mechanical analyses of the soil and subsoil of Puget fine sandy loam:

Mechanical analyses of Puget fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17741	Soil	0.1	0.5	0.3	27.0	32.1	35.5	4.2
17742.....	Subsoil.....	.0	.5	2.0	51.8	30.6	11.1	3.1

PUGET SILT LOAM.

The soil of the Puget silt loam, to an average depth of 15 to 20 inches, is a light-brown to drab silt loam containing a considerable amount of fine and very fine sand. The subsoil consists of a light-brown to gray fine sandy loam which is often slightly mottled with yellow iron stains. A relatively large quantity of silt is present in the sandy subsoil, especially in the upper 5 or 10 inches where it grades into the silty surface soil. The sand content has a uniform fine texture and the deeper subsoil contains very few, if any, pockets of coarse sand or gravel.

Extensive areas of the Puget silt loam occur in the valleys of the Nooksack and Sumas rivers, where it occupies broad, shallow depressions and level to gently undulating areas, occurring between the low ridge of Puget fine sandy loam bordering the immediate banks of the stream and the uplands which lie on the outer edge of the river valley. The natural drainage in the level or gently undulating areas is fairly

good, but in the depressions it is often very poor and artificial drainage is necessary to obtain the best results.

Very little of the Puget silt loam in the valley of the Sumas River is at present subject to overflow, but large areas in the Nooksack Valley are flooded. The soil has been formed from deposits of fine sand, silt, and clay laid down by the waters of the rivers. The greater proportion of the river valleys was formerly covered by a fine sandy deposit which now forms the subsoil of this type; the soil proper has been formed from more recent deposits of silt and clay.

This soil can be cleared for farming with less difficulty than that occupying the rolling uplands, and on account of its fine silty texture is easily brought to a high state of cultivation. A large part of its area is either under cultivation or is utilized as pasture. The principal crops are hay and oats. The average yield of oats, which is an unfailing crop, varies from 70 to 100 bushels per acre. The hay grown consists of clover and timothy and the average yield per acre is about 3 tons of hay. Irish potatoes do well on the better drained land, yielding from 6 to 8 tons per acre. Both raspberries and blackberries are well adapted to the soil, and with careful culture yield from 400 to 700 crates, each of 24 quarts, per acre. Cabbage, beets, tomatoes, peas, and other garden truck are successfully grown for the local markets. Canadian field peas produce an average of 40 to 60 bushels per acre.

When cleared and cultivated this land is valued at \$100 to \$200 an acre; when uncleared it can be purchased for \$75 to \$100 an acre, according to location and drainage.

The following table gives the results of mechanical analyses of the soil and subsoil of the Puget silt loam:

Mechanical analyses of Puget silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
17717.....	Soil	0.1	0.9	0.4	1.4	8.5	74.7	13.7
17718.....	Subsoil.....	.0	.2	.1	25.2	30.7	38.2	4.6

PUGET CLAY.

The soil of the Puget clay is a drab or slightly mottled heavy silt loam, containing a large quantity of organic matter in various stages of decomposition. It has an average depth of 15 to 20 inches and grades into a heavy, slightly mottled, silty loam or silty clay subsoil, which is very similar in texture to the surface soil. The subsoil is usually in a more or less thoroughly saturated condition and is

sticky and plastic. This causes the material to have the characteristics of a soil of heavier texture.

The remains of old logs and deposits of partially decomposed organic matter are sometimes found in the deeper subsoil, and a considerable amount of decomposed vegetable matter is usually present throughout the 3-foot section.

The larger areas of the Puget clay are found in the valley of the Nooksack River, but a few small areas also occur in the valley of the Sumas. It occupies low, flat areas which are usually subject to overflow, and forms the low delta flats near the mouth of the river. The level marshes in the same situation are being gradually built up by the deposition of silt and clay from the river, and represent an early stage of the delta-land phase of this type.

The topographical position of this soil accounts for its poorly drained condition, and in areas where no artificial drainage is used the water table is very near the surface. Open ditches are usually employed to carry off the excess water, but even where this is done the subsoil remains in a saturated condition during the greater part of the year.

The Puget clay is derived from the silt and clay deposited in these low, flat areas by quiet waters during floods. A large proportion of these areas contains quantities of organic matter, the remains of decomposed swamp vegetation, as well as shallow deposits of Peat.

The land does not support a heavy growth of timber and can easily be put in cultivation. A large part of it is already cleared. Portions that are well drained are used for cultivated crops and the rest as pasture.

The soil is well adapted to oats, giving very large yields—on the better drained land from 80 to 100 bushels per acre, with reported maximum yields of 125 bushels per acre. Barley has been grown to a limited extent and produces an average yield of 45 bushels per acre. Wheat has also been grown in a small way and yielded well, but the grain produced was too soft for milling, and at the present time this crop is not grown in the area. Clover and timothy do well on the better drained areas, producing from 3 to 5 tons of a very fair quality of hay to the acre. With favorable moisture conditions in the soil, potatoes, vegetables, and small fruits thrive. Very few orchards have been set out, owing to saturated condition of the subsoil, but on well-drained soil orchards do well. Apples, pears, plums, and cherries are grown.

Tile drainage would greatly increase the agricultural value of the land. At present the price ranges from \$75 to \$200 an acre, according to location and improvements.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Puget clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
16986, 17721.....	Soil	0.1	0.6	0.3	1.0	1.3	68.9	27.7
16987, 17722.....	Subsoil.....	.5	.6	.3	.9	1.0	72.2	24.0

COASTAL BEACHES.

The Coastal beaches consist of a coarse, loamy sand, containing a large quantity of rounded gravel. The color varies from gray to light brown, according to the quantity of organic matter present. The texture of the subsoil is like that of the surface, but in the lower depths it does not contain as much organic matter and is lighter in color.

This type of soil forms the sea beaches, which are seldom wide enough to indicate on a map of the scale used. The larger areas are found along some of the shallow bays and inlets, where the coast line has been gradually built out into the water by the continued deposition of sand and gravel by the action of the waves. The type is purely a beach deposit and is so limited in extent that it is of no agricultural importance.

SWAMP.

The area mapped as Swamp is situated in the lower valley of the Nooksack River and comprises about 2 square miles. This area remains wet and flooded during the entire year and supports a heavy growth of tules, coarse grasses, and other swamp vegetation. A large quantity of sediment is annually left in this area by the river at times of high water, and it is gradually being filled up by a sandy deposit similar to that which forms the Puget fine sandy loam. This area is at present too wet and poorly drained to be of any agricultural value.

TIDAL SWAMP AND MARSH.

An area mapped as Tidal swamp and marsh occurs at the mouth of a branch of the Nooksack River, known as the Lummi River. A smaller area is also located at the mouth of the main branch of the Nooksack. These areas have only a slight elevation above the tide and are often flooded by salt water from the sound at times of storms.

The marshes are covered by a heavy growth of coarse grasses and there is a mat 2 to 4 feet thick of fibrous organic matter formed from the remains of this vegetation in various stages of decomposition.

The underlying soil, a drab-colored heavy silt loam or silty clay, remains always in a saturated condition. Only by means of dikes and drainage, which would have to be done by pumping, can this land be reclaimed. In any event, the deep fibrous deposit of organic matter makes cultivation very difficult. These salt marshes have been formed by the deposition of silt and clay from the streams in the shallow water of the bay.

PEAT.

The deep accumulations of organic matter which occupy considerable areas in various sections of the area surveyed have been classed as Peat. This vegetable matter is in fibrous, partially decomposed condition, and the deposits vary in depth from 6 inches to more than 10 feet. These deposits at the surface usually have a dark-brown color. At a depth of 3 feet or more the color is usually darker and decomposition is in a more advanced stage.

Areas of Muck formed by the more thorough decomposition of this material are frequently encountered in all of the larger areas of Peat. The Muck areas are slightly darker in color than those occupied by the material of a more fibrous texture, and usually contain a higher percentage of silt and clay mixed with the organic matter. These two stages in the decomposition of these deposits are so closely related and grade into each other so frequently and within such narrow limits that it was found impracticable to separate them in a map on the scale of 1 mile to the inch.

The greater part of the peaty accumulations, however, has a coarse, fibrous texture, only the material found at a depth of several feet below the surface being decomposed sufficiently to be classed as Muck. One of the largest unbroken bodies of Peat, found in the northern part of the survey, covers an area of approximately 3 square miles in the broad flat plain or basin known as "Lynden Prairie." This whole basin was formerly covered by a deposit of Peat, but in the process of reclamation of the land the organic material has been largely burned off. An extensive area occupies the broad, poorly drained, depression east of Custer, and another area covering several square miles is found in the Nooksack Valley near the central part of the survey. Smaller deposits occupy small, poorly drained basins in many other localities. The larger areas also are found in poorly drained depressions, which receive the drainage water from the land surrounding them, but in several places similar deposits occupy knolls or ridges or the gentle slopes of the rounded hills. The Peat found here has been formed where small springs occur or where the drainage water from higher-lying areas seeps out. The rank growth of vegetation hinders the natural drainage of the land and the slow decomposition of this vegetable matter under the wet conditions gradually forms areas of shallow organic soils. Some of the areas of Peat

in the valley of the Nooksack River are subject to overflow at times of high water, and the silt and clay held in suspension by the water of the stream are deposited over the accumulations of organic matter forming a layer of silty soil, often several inches deep. These areas have been indicated on the soil map by means of a symbol.

The characteristic growth consists of cedar, jack pine, and dense, low bushes. Some areas support a growth of cranberry bushes and are locally known as cranberry marshes.

On account of its fibrous texture Peat is very difficult to cultivate and is used mainly for pasture or mowing lands. A few small areas have been drained and cultivated and yield fair crops of oats. Limited experiments have shown that the mucky areas will produce onions and celery profitably. Hay on the better drained areas does well and from 3 to 5 tons an acre are obtained, but it is of poor quality on account of the coarse wild grasses mixed with it.

SUMMARY.

The Bellingham area comprises 245,696 acres, or about 384 square miles of the northwestern part of Whatcom County, Wash.

For the most part the surface is rolling, but a glacial valley, which crosses the area from east to west and extends a branch to the northwest, has more gentle topography. A little of the area is mountainous.

Drainage is afforded by the Nooksack and Sumas rivers and Dakota and California creeks.

Settlement in the uplands is scattering; the river valleys are comparatively thickly settled.

Bellingham, population about 30,000, is the principal town and chief local market. Seattle and Tacoma, together with the Canadian cities, Vancouver and Victoria, offer ready market for all produce of the area.

Facilities for transportation, both by rail and water, are available.

The climate is mild throughout the year, and the rainfall is much less than in many parts of the "sound" country, being only 32 inches a year.

Grain and hay are the principal crops in the valleys, and small fruits, potatoes, and other vegetables in the uplands. Fruit growing is rapidly becoming one of the important industries. Dairying is important and profitable. Flower bulb growing has been tried and promises to be a money-making specialty. Farm labor is scarce but efficient.

Undeveloped farm land can be obtained for \$10 to \$75 an acre, while improved land ranges in value from \$75 to \$500 an acre.

Sixteen types of soil, including Peat, Swamp, and Tidal swamp and marsh are found. Of these the Whatcom silt loam is the most

extensive. Only a small proportion is under cultivation. The soil is productive and well adapted to tree and small fruits, and to potatoes and other vegetables.

The Lynden silt loam, an upland type, is well adapted to fruit. Small areas are used successfully in the production of vegetables. Only a limited acreage is under cultivation.

The Lynden sandy loam produces good yields of fruit, small fruits, and vegetables, but as yet no large areas of this type of soil are under cultivation.

The Lynden fine sandy loam—an easily cultivated soil—also produces good yields of tree and small fruits, and of clover and timothy hay.

Much of the Custer silt loam is cultivated. It produces good yields of oats, fruit, and vegetables.

Little of the Lynden gravelly loam is under cultivation. The orchards do well and vegetables also thrive on the more level areas.

Only a small part of Whatcom stony loam is suitable for agriculture. It occupies the mountainous parts of the area, and is valuable for its timber.

Occupying poorly drained basins, the Bellingham silt loam is used principally for hay. It is well adapted to clover and timothy, and where drained it produces fair yields of vegetables.

Another soil, the Custer loam, is in need of drainage. Drained areas give good yields of oats, hay, and vegetables.

The Puget fine sandy loam, found on a narrow ridge bordering the rivers, is a well-drained productive soil. It is used for small fruits and vegetables, and is especially well adapted to blackberries and raspberries.

When well drained the river bottom type, Puget silt loam, is a very productive soil. Seventy-five to 100 bushels of oats per acre may be secured. The soil is also well adapted to blackberries and raspberries.

The Puget clay, if adequately drained, produces large yields of hay and phenomenal yields of oats, ranging from 70 to 125 bushels, with occasionally yields of 150 bushels to the acre.

The nicer adaptations of soils to crops, so far as they have been determined to this time, may be summarized thus: For blackberries and raspberries, Puget fine sandy loam and Puget silt loam; for clover, the more level areas of Whatcom silt loam; for timothy, the Whatcom silt loam, Bellingham silt loam, and Puget silt loam; for tree fruits, all well-drained soils, but especially the Lynden gravelly loam; and for flower bulbs, the Whatcom silt loam and Lynden fine sandy loam.

APPENDIX.

The demand for the annual Reports of Field Operations of the Bureau of Soils for 1899, 1900, 1901, 1902, 1903, 1904, and 1905 has been so great that the quota allotted to the Department for distribution to exchanges, libraries, and other public institutions and to private persons cooperating has been reduced to such an extent that it will be necessary to restrict the distribution of the bound volumes of these publications as much as possible.

Many applications for the reports named are from persons interested in only one or two areas, and to provide for such requests separate reprints of the reports and maps in pamphlet form, covering each of the areas surveyed, have been obtained, which will in many cases answer the purpose of the correspondent. A list of these reports and reprints follows, and any available reprint desired will be forwarded upon application to the Chief of the Bureau of Soils.

Copies of the bound volumes are on sale by the Superintendent of Documents, Government Printing Office, Washington, D. C., at the prices named.

Field Operations of the Division of Soils, 1899. (First Report.) By Milton Whitney, Chief of Division. With accompanying papers by Thomas H. Means, Frank D. Gardner, Clarence W. Dorsey, Frank K. Cameron, and Lyman J. Briggs. Pp. 198, pls. 29, figs. 19, lithograph maps 11. 1900. Price 95 cents.

REPRINTS.^a

- A Soil Survey in the Pecos Valley, New Mexico (parts of Eddy and Chaves counties, 129 square miles): Two soil maps, 2 alkali maps, 2 underground water maps. By Thomas H. Means and Frank D. Gardner. (Reprint exhausted.)
- A Soil Survey in Salt Lake Valley, Utah (part of Salt Lake County, 249 square miles): One soil map, 1 alkali map, 1 black alkali map, 1 underground water map. By Frank D. Gardner and John Stewart.
- A Reconnaissance in Sanpete, Cache, and Utah counties, Utah. By Thomas H. Means. (Reprint exhausted.)
- A Reconnaissance in the Cache la Poudre Valley, Colorado. By Thomas H. Means. (Reprint exhausted.)
- A Soil Survey in the Connecticut Valley, Connecticut and Massachusetts (parts of Hartford (Conn.) and Hampden counties (Mass.) 388 square miles): One soil map. Clarence W. Dorsey and Jay A. Bonsteel. (Reprint exhausted.)

^a The several papers enumerated in this Appendix, with the accompanying maps, have been issued as separates and can be had upon application to the Bureau of Soils, except where exhausted, the editions of the papers so marked being exhausted. Beginning with 1903, the reports on individual areas are issued as advance sheets, and may be obtained upon application to the Senators for the State, the Representative within whose district the survey lies, or the Bureau of Soils, United States Department of Agriculture.

Field Operations of the Division of Soils, 1900. (Second Report.)
By Milton Whitney, Chief of Division. With accompanying papers by Thomas H. Means, Frank D. Gardner, Clarence W. Dorsey, Jay A. Bonsteel, William G. Smith, J. Garnett Holmes, Frank K. Cameron, Lyman J. Briggs, and Marcus L. Floyd. Pp. 474, pls. 51, figs. 47, lithograph maps 24. 1901. Price \$1.80.

REPRINTS.

- A. Soil Survey around Lancaster, Pennsylvania (part of Lancaster County, 269 square miles): One soil map. By Clarence W. Dorsey.
- Soil Survey of Montgomery County, Ohio (480 square miles): One soil map. By Clarence W. Dorsey and George N. Coffey.
- Soil Survey of Cecil County, Maryland (376 square miles): One soil map. By Clarence W. Dorsey and Jay A. Bonsteel.
- Soil Survey of St. Mary County, Maryland (363 square miles): One soil map. By Jay A. Bonsteel.
- Soil Survey of Calvert County, Maryland (217 square miles): One soil map. By Jay A. Bonsteel and R. T. Avon Burke.
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Field Operations of the Bureau of Soils, 1901. (Third Report.)
By Milton Whitney, Chief of Bureau. With accompanying papers by assistants in charge of field parties. Pp. 647, pls. 96, figs. 25, lithograph maps 31. 1902. Price \$2.25.

REPRINTS.

- Soil Survey of the Westfield Area, New York (part of Chautauqua County, 260 square miles): One soil map. By R. T. Avon Burke and Herbert W. Marean.
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- Field Operations of the Bureau of Soils, 1902. (Fourth Report.) By Milton Whitney, Chief. With accompanying papers by assistants in charge of field parties. Pp. 842, pls. 60, figs. 25, Maps 44. 1904. Price, cloth, \$3.80.

REPRINTS.

- Soil Survey of the Bigflats Area, New York (parts of Chemung and Steuben counties, 223 square miles): One soil map. By Louis Mesmer and W. Edward Hearn.
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- Soil Survey of the Grand Forks Area, North Dakota (part of Grand Forks County, 314 square miles): One soil map, 1 alkali map (colored plate), 1 underground water map (colored plate). By Charles A. Jensen and N. P. Neill.

Soil Survey of the Billings Area, Montana (part of Yellowstone County, 107 square miles): One soil map, 1 alkali map, 1 underground water map, 1 colored plate. By Charles A. Jensen and N. P. Neill.

Soil Survey of the Lewiston Area, Idaho (parts of Nez Perces and Latah counties, 308 square miles): One soil map. By Louis Mesmer.

Soil Survey of the Walla Walla Area, Washington (part of Wallawalla County, 201 square miles): One soil map, 1 black alkali map (colored plate). By J. Garnett Holmes.

Soil Survey of the Lower Arkansas Valley, Colorado (parts of Otero, Bent, Prowers, and Kiowa counties, 945 square miles): Four soil maps, 4 alkali maps (colored plates), 4 underground water maps (colored plates). By Macy H. Lapham and party.

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Field Operations of the Bureau of Soils, 1903. (Fifth Report.) By Milton Whitney, Chief. With accompanying papers by assistants in charge of field parties. Pp. 1,310, figs. 61, maps 78. 1904. Price, \$6.35.

ADVANCE SHEETS.

Soil Survey of the Fort Payne Area, Alabama (parts of Dekalb and Cherokee counties, 509 square miles): One soil map. By Grove B. Jones and M. E. Carr.

Soil Survey of the Huntsville Area, Alabama (parts of Limestone and Madison counties, 506 square miles): One soil map. By Frank Bennett, jr., and A. M. Griffen.

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Field Operations of the Bureau of Soils, 1904. (Sixth Report.) By Milton Whitney, Chief. With accompanying papers by assistants in charge of field parties. Pp. 1, 159, pl. 1, figs. 45, maps 53. 1905.

ADVANCE SHEETS.

- Soil Survey of Rhode Island (1,085 square miles): Two soil maps. By F. E. Bonsteel and E. P. Carr.
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- Soil Survey of the Yuma Area, Arizona-California (parts of Yuma County, Ariz., and San Diego County, Cal., 340 square miles): One soil map, 1 alkali map. By J. Garnett Holmes, Charles A. Jensen, Herbert W. Marean, N. P. Neill, Aldert S. Root, W. E. McLendon, J. L. Burgess, A. T. Strahorn, and A. T. Sweet.
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- Soil Survey of the San Bernardino Area, California (parts of Orange, Riverside, and San Bernardino counties, 755 square miles): One soil map. By J. Garnett Holmes, N. P. Neill, W. E. McLendon, A. T. Sweet, Aldert S. Root, and Herbert W. Marean.

Field Operations of the Bureau of Soils, 1905. (Seventh Report.) By Milton Whitney, Chief. With accompanying papers by assistants in charge of field parties. Pp. 1,089, pl. 2, figs. 45, maps 47, 1906.

ADVANCE SHEETS.

- Soil Survey of Blount County, Alabama (625 square miles): One soil map. By William G. Smith and F. N. Meeker.
- Soil Survey of Dallas County, Alabama (992 square miles): One soil map. By E. P. Carr, W. Edward Hearn, Hugh H. Bennett, and R. T. Avon Burke.
- Soil Survey of Lauderdale County, Alabama (708 square miles): One soil map. By F. E. Bonsteel, Orla L. Ayrs, Thomas D. Rice, and E. P. Carr.
- Soil Survey of Montgomery County, Alabama (780 square miles): One soil map. By W. E. McLendon and Charles J. Mann.
- Soil Survey of the Stockton Area, California (part of San Joaquin County, 521 square miles): One soil map, 1 alkali map (colored plate), 1 black alkali map (colored plate). By Macy H. Lapham and W. W. Mackie.
- Soil Survey of the Grand Junction Area, Colorado (part of Mesa County, 168 square miles): One soil map, 1 alkali map. By J. Garnett Holmes and Thomas D. Rice.
- Soil Survey of Leon County, Florida (675 square miles): One soil map. By Henry J. Wilder, J. A. Drake, Grove B. Jones, and W. J. Geib.

- Soil Survey of Spalding County, Georgia (205 square miles): One soil map. By J. E. Lapham, W. S. Lyman, and Charles W. Ely.
- Soil Survey of Newton County, Indiana (393 square miles): One soil map. By N. P. Neill and W. E. Tharp.
- Soil Survey of Tippecanoe County, Indiana (499 square miles): One soil map. By N. P. Neill and W. E. Tharp.
- Soil Survey of Brown County, Kansas (573 square miles): One soil map. By James L. Burgess and W. E. Tharp.
- Soil Survey of Madison County, Kentucky (437 square miles): One soil map. By A. M. Griffin and Orla L. Ayrs.
- Soil Survey of McCracken County, Kentucky (242 square miles): One soil map. By Thomas D. Rice.
- Soil Survey of East Baton Rouge Parish, Louisiana (451 square miles): One soil map. By Charles W. Ely, H. W. Marean, and N. P. Neill.
- Soil Survey of Tangipahoa Parish, Louisiana (788 square miles): One soil map. By A. M. Griffin and Thomas A. Caine.
- Soil Survey of the Oxford Area, Michigan (part of Oakland County, 210 square miles): One soil map. By Grove B. Jones and M. Earl Carr.
- Soil Survey of the Carlton Area, Minnesota-Wisconsin (parts of Carlton and St. Louis counties, Minnesota, and Douglas County, Wisconsin, 413 square miles): One soil map. By W. J. Geib and Grove B. Jones.
- Soil Survey of the Crystal Springs Area, Mississippi (parts of Simpson and Copiah counties, 231 square miles): One soil map. By James L. Burgess and W. E. Tharp.
- Soil Survey of Crawford County, Missouri (747 square miles): One soil map. By W. Edward Hearn and Charles J. Mann.
- Soil Survey of Scotland County, Missouri (440 square miles): One soil map. By W. Edward Hearn and Charles J. Mann.
- Soil Survey of the Gallatin Valley Area, Montana (part of Gallatin County, 325 square miles): One soil map. By Macy H. Lapham and Charles W. Ely.
- Soil Survey of Sarpy County, Nebraska (227 square miles): One soil map. By A. E. Kocher and Lewis A. Hurst.
- Soil Survey of the Binghamton Area, New York (part of Broome County, 229 square miles): One soil map. By Elmer O. Fippin and William T. Carter, jr.
- Soil Survey of Tompkins County, New York (493 square miles): One soil map. By Jay A. Bonsteel, Elmer O. Fippin, and William T. Carter, jr.
- Soil Survey of Duplin County, North Carolina (824 square miles): One soil map. By A. S. Root and Lewis A. Hurst.
- Soil Survey of Pasquotank and Perquimans counties, North Carolina (461 square miles): One soil map. By J. E. Lapham and W. S. Lyman.
- Soil Survey of the Carrington Area, North Dakota (parts of Foster and Griggs counties, 432 square miles): Two soil maps. By A. E. Kocher and Lewis A. Hurst.
- Soil Survey of the Cleveland Area, Ohio (parts of Lorain, Summit, Cuyahoga, and Medina counties, 509 square miles): One soil map. By J. E. Lapham and Charles N. Mooney.
- Soil Survey of the Westerville Area, Ohio (parts of Delaware, Franklin, Licking, Madison, and Union counties, 476 square miles): One soil map. By J. E. Lapham and Charles N. Mooney.
- Soil Survey of Chester County, Pennsylvania (760 square miles): One soil map. By Henry J. Wilder, W. J. Geib, Thomas A. Caine, and William T. Carter, jr.
- Soil Survey of Montgomery County, Pennsylvania (496 square miles): One soil map. By Henry J. Wilder, A. T. Strahorn, and W. J. Geib.
- Soil Survey of Cherokee County, South Carolina (361 square miles): One soil map. By J. A. Drake and H. L. Belden.
- Soil Survey of York County, South Carolina (669 square miles): One soil map. By J. A. Drake and H. L. Belden.
- Soil Survey of Henderson County, Tennessee (499 square miles): One soil map. By M. Earl Carr and Frank Bennett.

- Soil Survey of Houston County, Texas (1,192 square miles): One soil map. By William T. Carter, jr., and A. E. Kocher.
- Soil Survey of Lavaca County, Texas (995 square miles): One soil map. By Charles N. Mooney, Frank Bennett, A. T. Strahorn, and H. L. Belden.
- Soil Survey of Lee County, Texas (666 square miles): One soil map. By James L. Burgess and W. S. Lyman.
- Soil Survey of the Waco Area, Texas (parts of Bosque and McLennan counties, 495 square miles): One soil map. By A. W. Mangum and M. Earl Carr.
- Soil Survey of Hanover County, Virginia (475 square miles): One soil map. By Hugh H. Bennett and W. E. McLendon.
- Soil Survey of Louisa County, Virginia (505 square miles): One soil map. By Hugh H. Bennett and W. E. McLendon.
- Soil Survey of the Yorktown Area, Virginia (Elizabeth City, York, James City, Gloucester, and Warwick counties, 598 square miles): One soil map. By R. T. Avon Burke and A. S. Root.
- Soil Survey of Island County, Washington (233 square miles): One soil map. By E. P. Carr and A. W. Mangum.
- Soil Survey of the Everett Area, Washington (part of Snohomish County, 525 square miles): One soil map. By E. P. Carr and A. W. Mangum.
- Soil Survey of Upshur County, West Virginia (330 square miles): One soil map. By A. M. Griffen and Orla L. Ayrs.
- Soil Survey of Portage County, Wisconsin (797 square miles): One soil map. By F. N. Meeker and R. T. Avon Burke.

Field Operations of the Bureau of Soils, 1906. (Eighth Report.)
 By Milton Whitney, Chief. With accompanying papers by assistants in charge of field parties. Pp. 1,033, figs. 34, maps 35. 1908. Price, \$4.40.

ADVANCE SHEETS.

- Soil Survey of Lee County, Alabama (629 square miles): One soil map. By W. Edward Hearn and W. J. Geib.
- Soil Survey of the Fayetteville Area, Arkansas (parts of Benton and Washington counties, 569 square miles): One soil map. By Henry J. Wilder and Charles F. Shaw.
- Soil Survey of Prairie County, Arkansas (613 square miles): One soil map. By William T. Carter, jr., F. N. Meeker, Howard C. Smith, and E. L. Worthen.
- Soil Survey of Escambia County, Florida (575 square miles): One soil map. By A. M. Griffen, J. A. Drake, H. L. Belden, and L. A. Kolbe.
- Soil Survey of the Waycross Area, Georgia (part of Ware County, 535 square miles): One soil map. By M. Earl Carr and W. E. Tharp.
- Soil Survey of Greene County, Indiana (535 square miles): One soil map. By W. E. Tharp and Charles J. Mann.
- Soil Survey of the Tishomingo Area, Indian Territory (part of District No. 22, 343 square miles): One soil map. By Thomas D. Rice and Orla L. Ayrs.
- Soil Survey of Riley County, Kansas (635 square miles): One soil map. By William T. Carter, jr., and Howard C. Smith.
- Soil Survey of Caddo Parish, Louisiana (869 square miles): Two soil maps. By James L. Burgess, Lewis A. Hurst, Henry J. Wilder, and Charles F. Shaw.
- Soil Survey of Cass County, Michigan (500 square miles): One soil map. By W. J. Geib.
- Soil Survey of Blue Earth County, Minnesota (749 square miles): One soil map. By Hugh H. Bennett and Lewis A. Hurst.
- Soil Survey of the Crookston Area, Minnesota (part of Polk County, 779 square miles): One soil map. By A. W. Mangum and Frank C. Schroeder.
- Soil Survey of Montgomery County, Mississippi (370 square miles): One soil map. By Thomas A. Caine and Frank C. Schroeder.
- Soil Survey of Pontotoc County, Mississippi (368 square miles): One soil map. By Frank Bennett and R. A. Winston.

- Soil Survey of Putnam County, Missouri (523 square miles): One soil map. By Charles J. Mann and W. E. Tharp.
- Soil Survey of Lancaster County, Nebraska (858 square miles): One soil map. By James L. Burgess and E. L. Worthen.
- Soil Survey of Merrimack County, New Hampshire (923 square miles): One soil map. By Charles N. Mooney, H. L. Westover, and Frank Bennett.
- Soil Survey of Niagara County, New York (547 square miles): One soil map. By Elmer O. Fippen, Grove B. Jones, W. J. Geib, Orla L. Ayrs, and C. W. Mann.
- Soil Survey of Madison County, New York (649 square miles): One soil map. By M. Earl Carr, A. M. Griffen, and Ora Lee, jr. (Exhausted.)
- Soil Survey of Chowan County, North Carolina (178 square miles): One soil map. By W. Edward Hearn, assisted by G. M. MacNider, of the State department of agriculture.
- Soil Survey of New Hanover County, North Carolina (18 square miles): One soil map. By J. A. Drake and H. L. Belden. (Exhausted.)
- Soil Survey of Transylvania County, North Carolina (372 square miles): One soil map. By W. Edward Hearn, assisted by G. M. MacNider, of the State department of agriculture.
- Soil Survey of Ransom County, North Dakota (856 square miles): One soil map. By Charles W. Ely, assisted by Rex E. Willard and J. T. Weaver.
- Soil Survey of the Williston Area, North Dakota (part of Williams County, 585 square miles): One soil map. By Thomas D. Rice.
- Soil Survey of Meigs County, Ohio (443 square miles): One soil map. By F. N. Meeker and G. W. Tailby, jr.
- Soil Survey of Oklahoma County, Oklahoma (850 square miles): One soil map. By W. E. McLendon and Grove B. Jones.
- Soil Survey of Grainger County, Tennessee (307 square miles): One soil map. By W. E. McLendon and W. S. Lyman.
- Soil Survey of Madison County, Tennessee (561 square miles): One soil map. By W. S. Lyman, W. E. McLendon, and Frank Bennett.
- Soil Survey of the Henderson Area, Texas (part of Rusk County, 506 square miles): One soil map. By Charles W. Ely and A. E. Kocher.
- Soil Survey of the Laredo Area, Texas (part of Webb County, 156 square miles): One soil map. By A. W. Mangum and Ora Lee, jr.
- Soil Survey of the San Marcos Area, Texas (parts of Hays, Guadalupe, Caldwell, and Bastrop counties, 420 square miles): One soil map. By A. W. Mangum and W. S. Lyman.
- Soil Survey of Chesterfield County, Virginia (478 square miles): One soil map. By Frank Bennett, R. A. Winston, W. J. Geib, and C. W. Mann.
- Soil Survey of the Wheeling Area, West Virginia (all of Ohio, Brooke, and Hancock counties, and part of Marshall County, 315 square miles): One soil map. By Thomas A. Caine and G. W. Tailby, jr.
- Soil Survey of Racine County, Wisconsin (326 square miles): One soil map. By Grove B. Jones and Orla L. Ayrs.

